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The Intelligibility of the Physical World in Plato's *Timaeus*

by

Rafal Dymarz

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A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfilment of the requirements of the degree of Master of Art.

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled The Intelligibility of the Physical World in Plato's "Timaeus" submitted by Rafal Dymarz in partial fulfillment of the requirements for the degree of Master of Arts.

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Abstract

Plato's *Timaeus* is a treatise about the physical world. Primarily, it is about the genesis and functioning of the cosmos, although genesis in the physical world on the subcosmic or terestrial level is given equally detailed coverage. My thesis is about the coming to be on this sobcosmic level. Unlike the cosmic phenomena which, due to the regularities in the motions of stars and planets, are intelligible to a reflective observer, the terrestrial phenomena seem to be chaotic and then unintelligible.

To make the terrestrial phenomena intelligible Plato postulates compositeness of the four Empedoclean elements on an 'atomic' level. Fire, air, water and earth are assumed to have the structures of the four regular solids: tetra-, octa-, ikosahedrons, and cube, respectively. This allows for a quantitative description of the intermutations between the elements on the microscopic level and in consequence makes physical phenomena on the terrestrial level intelligible. I argue that these solids are purely mathematical objects and that they are generated spontaneously by their respective mathematical Forms, both in the precosmos and in the cosmos. In the *Timaeus* the god is identified as the sole intelligent cause of the cosmos; he looks at the Form of the Living Thing and constructs the Universe, both its soul and body, using the existing material. As far as the body of the cosmos is concerned, the god uses the mathematical solids already existing in the precosmic state and imposes proportions on them. This results in transforming these mathematical entities into physical particles, for the proportions enable clustering of the individual particles into aggregates and in consequence allow for the interactions between the elements. Because the sense organs themselves are nothing but aggregates of the elements, the properties of the physical objects are functions of the interactions of these objects with sense organs, rather than some kind of entities inherently present in the objects.

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I dedicate this work first of all to my family: Elzbieta, Tullia, and Ania; but also to my high school teacher of Latin, a philosopher, Dr. W. Walek, trully a man of learning.

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INTRODUCTION

The *Timaeus* is a treatise about the physical world, its genesis and functioning. Its first part is the description of the physical world on the cosmic level, and its second and third parts are the description of genesis in the physical world on the subcosmic, or terrestrial, level. The cosmos as a whole is intelligible for a reflective observer, for it is evidently mathematically structured. It is plausible to assume that this mathematical structure might have been imposed on the cosmos solely by the intelligent divine craftsman. The physical world on the subcosmic level, on the other hand, is not perceived as orderly and mathematically structured, so it is not immediately obvious that it can be intelligible in the same way as the cosmos, and that there may be any intelligent agent behind the changes on the subcosmic level. Timaeus' 'likely story' (*eikos muthos*) is an attempt at formulating a model of the physical world on both the cosmic and subcosmic levels that would make the physical world on the terrestrial level intelligible in the same way as the cosmos is, i.e., mathematically. Within this model we have then a postulate of the divine craftsman constructing the cosmos, of which the body is composed out of the four Empedoclean elements, and then a postulate of mathematical structure of these elements with the god transforming these mathematical objects into physical particles. A very convincing description of changes on the terrestrial level in terms of this model makes Timaeus' hypotheses very attractive as a scientific theory of the physical world.[1]

The model postulates the explanation of genesis in the physical world in terms of two kinds of causes: intelligent or divine on the one hand, and necessary on the other hand. Timaeus makes it clear that the identification of both kinds of causes is important in every inquiry into the physical world for the divine cause is

[1] See the interesting comparison of the model of the cosmos as presented in the *Timaeus* with the model currently accepted, i.e. the big bang model in L. Brisson and F. M. Meyerstein, *Inventing the Universe*, 1995.

hidden always behind the necessary ones. The necessary causes may be identified as those acting already in the disorderly precosmos, and the intelligent cause as that responsible for the orderly universe. The cosmos as it is now, however, is a playground of both kinds of causes, for, as Timaeus tells us, this world has come into existence through the persuasion of Necessity by Intelligence that it 'direct most of the things that come to be towards what is best' [48a].[2] In order to be able to identify the divine cause and distinguish it from the necessary causes in the cosmos today we have to be sure about the content of the precosmos and god-alleged activity on it at the time the universe was constructed. In my essay I try to do just that, i.e., to determine the content and the dynamic state of the precosmos and god's alleged activity on this content as it is presented in the *Timaeus*. I argue that the content of the precosmos was purely mathematical, i.e., that it was the flood of all kinds of mathematical objects, among them stereometric bodies. I see these mathematical objects as images of mathematical Forms and I understand the instantiation of such images, both in the precosmos as well as in the cosmos, as spontaneous events caused by the Forms solely. These images of mathematical Forms are perfect mathematical objects and god's intervention is necessary neither for their instantiation, nor for making them perfect. The god intervenes in this world of chaotically moving mathematical entities by imposing proportions on the four regular stereometric bodies, and that enables these objects to cluster and interact with one another. The proportions which the god imposes on the stereometric figures may be seen as the Forms of the elements, for they now allow for the manifestation macroscopically, what we call 'properties' or 'qualities' of the objects, through the interaction of these physical objects with sense organs. In short, the god, by imposing proportions on mathematical objects, turned the precosmic mathematical world into the world of physical bodies. That it is the mathematical entities that populate the precosmos, I claim, is supported by the

[2] All references to the *Timaeus* are given by quoting Stephanus page only. The references to other Plato's dialogues are also in brackets but the page is proceded by the abbreviated title of the dialogue.

way the stereometric bodies are introduced. As I see it, they are introduced in the central part of the dialogue as mathematical principles; the god, then, uses them as a suitable material to construct the physical world in which the four elements are able to interact with one another according to the pattern determined by their respective Forms. The description of the mechanism of interactions and intermutations of the elements further supports my claim, I think, that this interaction is characteristic of clusters of particles rather than of individual particles, clusters that are formed by the proportions the god imposes on the noninteracting mathematical bodies. The elaborate description of the physical substances, their 'qualities', and the mechanism of sensation, I think, is a persuasive demonstration that the model of the physical world proposed in the *Timaeus* requires no Forms of 'qualities', for qualities or properties of physical objects are functions of the interaction of these objects with sense organs.

I supplement my thesis about the content of the precosmic receptacle and alleged god's activity on it with an interpretation of the dynamic state of the receptacle by proposing a possible mechanism of agitation of the receptacle. The agitation of the receptacle is introduced in the description of the precosmos and confirmed in the description of the cosmos, and is said to be responsible for the chaotic motion of the elements into separate regions; it is, then, difficult to dismiss it as a metaphor. The agitation of the receptacle, I think, is the result of imparting into it a small amount of motion at the moment of instantiation of the image of the stereometric body. An equal amount of motion, I argue, is taken away from the receptacle when the stereometric body disintegrates into its component triangles. In this interpretation, the agitation of the receptacle is purely a kinematic effect and it requires no 'powers' responsible for initiating this motion.

In my essay I am interested almost exclusively in the genesis on the terrestrial level as described in the second or central part of the dialogue [47e-69b], touching

only briefly on the genesis of the cosmos, as described in the first part of the dialogue [27d-47e], and referring only occasionally to the third, or last part of the dialogue [69b-91c]. I will start in Chapter II with the cosmos as a whole, but I will be interested in this Chapter neither with the details of the genesis, nor with the functioning of the cosmos, but solely with the principles of the genesis and their bearing on the intelligibility of the physical world on the terrestrial level. In the first section of Chapter II I will identify the principles and causes that Timaeus introduces within his 'likely story' in order to make it probable. Among these principles, the foremost are those of Plato's Theory of Forms, as well as the teleological principle represented by the divine craftsman who is identified also as the cause of the cosmos. The four Empedoclean elements, fire, air, water, and earth, are treated on this level as if they were material principles. The divine craftsman is identified as the sole cause of the cosmos, and the material principles he uses as 'accessory' or 'auxiliary' causes. The Form of Living Thing, which the god copies, plays the role of the paradigm, rather than that of the cause. In the second section of this Chapter I will discuss in some detail the notion of proportion as a bonding force in the physical world; this notion is introduced on the cosmic level, but it is of great importance, I will argue, for the intelligibility of the becoming on the subcosmic level as well.

Chapters III and IV are devoted to the changes on the subcosmic, or terrestrial level. Both Chapters deal with the second, or central part of the dialogue [47e-69b]. The greater portion of that part of the dialogue deals with the geometrical model of becoming and the description of changes on the terrestrial level in terms of this model. By geometrical model I understand two things combined: the first is the geometrical structure of the elements, and the second is a mechanics of their intermutations. As I have indicated above, I see the structure of the elements as purely mathematical and originating in what Plato calls Necessity, while the in-

teraction originates in the proportions imposed on these mathematical structures by the god. The geometrical model of becoming is, then, evidently connected with god's activity, and god's activity marks the beginning of the cosmos. However, in order to identify this activity properly we have to be able first to identify the precosmic state, i.e., the state of affairs before the god enters the scene. Timaeus makes several remarks in this part of the dialogue from which we should be able in principle to infer the state of the precosmos. Unfortunately, by no means are these remarks enlightening. I discuss the controversies surrounding the interpretations of these remarks in Chapter III. I begin this Chapter with a short discussion of the Theory of Forms, as I think it is presented at the beginning of the central part, and applied in the *Timaeus* in general, with the receptacle of becoming as a new principle within this Theory. Then, I present my interpretation of the content of the precosmic receptacle and discuss positions of other commentators on this topic. Generally I distinguish two positions among those taken by commentators on the precosmos. The first position is that the precosmic receptacle contains some geometrical objects in one way or another. This position is close to mine, but none of the commentators in this group allows for perfect stereometric bodies to populate the precosmos. The other position is that the precosmic receptacle contains some kind of 'qualities' of the four elements on which the god imposes 'forms and numbers' [53b]. These qualities may or may not be the images of respective Forms. In the last section I will address the problem of the Straying Cause; I will argue there that the agitation of the receptacle should be identified with what Plato calls the Straying Cause. Most commentators equate the Straying Cause with Necessity as such, but I think that it refers exclusively to the mechanical motion, i.e., simple agitation of the receptacle, that is present in both the precosmos and in the cosmos. I will argue for a specific mechanism of producing such an agitation that, as I have mentioned above, is the result of spontaneous instantiation of the mathematical stereometric bodies in the receptacle.

In Chapter IV I will discuss the geometrical model itself. The main aim of this Chapter is to supply additional support for my interpretation of the precosmos and god's alleged activity proposed in Chapter III. In particular, I will argue that the way Timaeus introduces the two right triangles as a principle of the elements suggests that, while introducing them he is interested not so much in practical matters of constructing the bodies of the elements, as in exploiting the mathematical principles as applicable to the construction of higher order (in dimension) mathematical objects. It is evident that he mentions the god only as introducing proportions on the ready to use mathematical constructs. These proportions introduce aggregation of the particles and their interactions. Further, I will show that the way Timaeus discusses intermutations of the elements suggests that it is aggregates of the particles, rather than individual particles themselves, that have the power to interact. In the last section of this Chapter, I will argue that the unified description of substances, their properties and sensations, which is, indeed, very persuasive, suggests that all qualities atributed to the substances originate in the interaction between the substances and sense organs, and because both substances and organs of perception are constructed out of the clusters of the same four elements, the 'qualities' are, in the final instance, functions of these interactions between the elements and they are intelligibly rendered within the geometrical model. There is no need to postulate 'qualities' that might existed in the precosmic receptacle, as many commentators believe, in order to account for the qualities of substances in the physical world.

II. THE INTELLIGIBILITY OF THE COSMOS

The cosmos as a whole is intelligible, for we find measure and harmony in it, Timaeus thinks, and at the end of the first part of the dialogue, the one devoted to the cosmos, he says: 'our ability to see periods of day and night, of months and of years, of equinoxes and solstices, has led to the invention of number, and has given us the idea of time and opened the path to inquiry into the nature of the universe' [47a]. This inquiry is certainly a kind of philosophical reflection on what we perceive, and in particular what we see and what we hear, for Plato says that sight and hearing are of supreme benefit for us and they are obviously gifts from god [47a,c]. The god gave them to us, however, not merely for the purpose of inquiry into the nature of the universe, but first of all for the reason that 'we might observe the orbits of intelligence in the universe and apply them to the revolutions of our own understanding. For there is a kinship between them...'[47b-c]. Finding this kinship between the cosmos and ourselves will allow us to live a happy life. We need to discover this kinship, for 'most of us....have lost all sense of measure, and are lacking in grace' [47e]. This argument about the kinship between ourselves and the cosmos is elaborated upon, as I have already mentioned, at the end of the first part of the dialogue, the one devoted to the cosmos. But this is not the only place where Plato links inquiry into the physical world with an ethical goal. The other place where Plato makes such a connection is the summary at the end of the central part of the dialogue of which the genesis in the physical world on the terrestrial level is the main concern. Here Plato has Timaeus saying that we should look always for necessary causes as well as for a divine cause: 'First for divine, for which we must search in all things if we are to gain a life of happiness to the extent that our nature allows, and second, the necessary, for which we must search for the sake of divine' [68e]. The life of happiness, as we learn at the end of the third, or last, part of the dialogue, is the life of harmonious development of

our soul and body [87c-88b]. If practiced in life, this harmonious development of man's soul and his body will be the imitation of the cosmic harmony that Plato urged a philosopher to inquire into.

In this Chapter I will concentrate on the first, or cosmic, part of the dialogue, but I will not go into any details. I confine myself, rather, to pointing to the principles and causes that Plato introduces on the cosmic level, for we expect these principles and causes to be valid on the subcosmic level as well. In the first section I will identify these principles and causes. In the second section I will discuss at some length the problem of proportion the god introduces as the binding force in the world body that assures its unity. This particular proportion is introduced on the cosmic level but, as we will learn later, the proportions in general are of great importance in the explanation of becoming in the physical world on the terrestrial level as well.

1. The Principles and Causes on the Cosmic Level

Timaeus calls his inquiry into becoming a 'likely story'; it is 'likely', Timaeus says, for it is only about likenesses of things which always are [29b-c]. Already this tells us that these basic distinctions of Platonic metaphysics, that between 'things that always are' (presumably the Forms) and contingent things is the basic one in the account of becoming in the *Timaeus*. In fact, Timaeus begins his 'likely story' just from the confirmation of the basic principles of Plato's Theory of Forms. He says: 'we must begin by making the following distinction: What is *that which always is* and has no becoming, and what is *that which becomes* but never is?' [27d-28a] This is essentially all that we are told about this fundamental distinction here, for Plato perhaps thought this to be an adequate introduction for his description of the genesis of the cosmos; the Forms, after all, in this part of the dialogue play a rather limited role, namely those of paradigms, or models for the god. The Theory

of Forms will be developed more fully at the beginning of the central part of the dialogue where the third principle, the receptacle of becoming, will be introduced and then related to the other two. It should, however, be observed here that Plato begins both the description of the genesis of the cosmos and the description of terrestrial genesis with reference to the Theory of Forms. This clearly indicates that the Theory is one of the basic ingredients of his account of becoming in the *Timaeus*, despite the fact that the god is identified as the teleological principle and the sole cause of becoming.

The god is introduced immediately after the distinction between being and becoming has been made. We are told that everything that comes to existence 'must of necessity come to be by the agency of some cause' [28a], and then the cause is equated with the craftsman who, if he looks at the changeless model, while performing his task, delivers 'of necessity' a product which is beautiful [28b]. The application of this conditional argument to the 'whole universe' takes the form of a syllogism whose conclusion is about the model. The two premises of this syllogism are that the cosmos is beautiful and that the craftsman is good,[3] and the conclusion is that the model the god looked at was eternal [29a]. This whole discussion allows Timaeus to put the emphasis on the status of the cosmos as the 'image of something', and then to introduce the basic characteristics of his account of becoming, already mentioned briefly above. Only an account of 'stable and unshifting' things can be stable and 'transparent for understanding', Timaeus says, but his account, because it will be an account of 'what is a likeness', will also be only likely. His account aims at convincingness, not at truth, for it is about becoming; truth may be reached solely in an account of being, for as 'what being is to becoming, truth is to convincingness' [29c]. Since every account of becoming has this obvious deficiency, Timaeus says, he will not be able to produce 'accounts on a great many subjects - on gods or the coming to be of the universe - that is

[3]The beauty of the world is perhaps known by inspection and to think that the god is not good would perhaps be blasphemous.

completely and perfectly consistent and accurate' [29c].

The intelligent craftsman constructs the copy of the Form of the Living Thing. This copy is the existing universe, the living thing itself, and it is composed of soul and body. The craftsman uses some pre-existing material to accomplish his task; some metaphysical principles to construct the world soul and the four Empedoclean elements as a material for the construction of the body of the world. He calls these elements 'accessory causes' (*sunaitiai*). In what follows, I will discuss briefly the principles and causes introduced on the cosmic level.

1.1 The god as the teleological principle and the cause on the cosmic level

Every becoming, as Timaeus says, has to have its cause, and on the cosmic level it is the divine craftsman who is identified as the sole cause of the cosmos. The craftsman, however, is not omnipotent; he has to look at the model and use some material in order to accomplish his task. The cosmic craftsman, we are told, is good, our world is beautiful, and the model is eternal [29a]. The goodness is essentially the only characteristic of the god we are given, and the other characteristics of the god originate in his goodness; since he is good, we are told, he is without jealousy [29e]. God's goodness is, then, also the reason that this world has come into existence in the first place, and his goodness also explains why the god made the copy of the Form of the Living Thing as close to the model as possible [29e-30e]. Being good, the god wanted everything he was doing to be good as well, 'so far as that was possible' [30a]. The 'good' may be seen, then, as the principle according to which this world is organized.[4] What the god was dealing with, as far as the construction of the body of the world is concerned, was essentially the 'visible' things which were in 'discordant and disorderly motion'

[4] Taylor, 1929, p85: Taylor says that the belief that 'there is just one single organizing principle at work everywhere, - the *good*' Plato inherited from Socrates and that it was 'most ultimate of Plato's philosophical convictions'.

and he put them in order, for 'he believed that order was in every way better than disorder' [30a]. In the realm of 'things naturally visible', Timaeus says, what is best is the ensouled intelligence, with the soul being placed into the body; so the god made the universe just that: the embodied soul [30b].

The god is, then, the sole intelligent cause of the genesis of the cosmos. But he himself creates other intelligent creatures that can act purposefully toward the good end. These are: the secondary gods, the world soul, and the souls of human beings. The secondary gods are assigned the task of constructing the body of man and the mortal parts of his soul. The world soul is embodied and takes over god's place as a sustainer of the order in the universe when he himself retires after accomplishing his task [42e]. Presently, then, when a philosopher in his inquiry into the physical world will look for causes that 'belong to intelligent nature' [46d], he will evidently look for soul on both cosmic and subcosmic levels; only the genesis of the cosmos requires postulating of the existence of the god. While the secondary gods and the world soul always act toward the good without impediment, the human soul, since it is impeded by its irrational parts and the body, does not always act toward the best.

1.2 The Forms as paradigms

The universe which the god constructed is a living creature: the embodied intelligent soul, and the god constructed this creature, while looking at the model, the Living Thing. The model, as Timaeus says, has to be eternal, in order for the product to be excellent, so the Living Thing is evidently the Form, containing perhaps in itself other Forms, at least those of other living things,[5] and perhaps the Forms of the four elements. The Forms, then, play the role of paradigms in this part of the dialogue; they, or participation in them, are never considered here

[5] See, for example, Ross, p129-30.

as causes, for the notion of 'participation' in the Form as the cause of acquiring some properties is absent in the *Timaeus* both on the cosmic as well as on the subcosmic levels. On the cosmic level it is the god who is identified as the sole cause of the coming to be of the universe. The material the god uses, i.e., the elements, is called 'accessory causes'. A proper question to ask in this place is how the Forms in the *Timaeus* differ from those in the middle-term dialogues, and in particular in the *Phaedo* where the Theory of Forms is eleborated most fully as far as earlier dialogues are concerned.

1) The Forms and Causes in the *Phaedo*

In the *Phaedo* Plato has Socrates looking for causes of generation in the physical world on the terrestrial level and also in the cosmos [Phdo:96a-105c]. Socrates is not satisfied with the mechanistic explanation of becoming in the physical world and in the cosmos as offered by current theories, and he also dismisses as inadequate some attempts at proto-teleological explanation, like that of Anaxagoras, who referred to Mind as a cause of becoming. To be sure, Socrates still prefers teleological explanation in the spirit of that proposed by Anaxagoras, but he can neither accept Anaxagoras' model, nor is he himself able to find a proper intelligent agent behind becoming on both the cosmic and subcosmic levels. This difficulty with formulating a satisfactory teleological model of explanation prompts him to adopt the 'second best' method of explanation, the one based on the Theory of Forms. The model is second best, we may assume, to the teleological one.

But in the *Phaedo* Socrates applies the 'second best' method exclusively to becoming in the physical world on the terrestrial level; the cosmic becoming is not considered at all within this method, and in the eschatological myth that closes the dialogue [Phdo:108 ff] Socrates applies a mechanistic explanation of cosmic

phenomena rather than teleological.[6] The essence of this new method is that things acquire some properties, as Socrates argues, by 'participating' in the eternal Forms. What this participation is, is not clear at all, and in one place Socrates states this explicitly: 'nothing else makes it [the thing] beautiful other than the presence of, or the sharing in, or however you may describe its relationship to that Beautiful we mentioned' [Phdo:100d]. Later Socrates introduces the 'character' corresponding to the given Form as residing in the phenomenal object, but this does not make clearer the nature of the causal relation between the Form and the relevant property of the object in which the 'character' resides.[7] In Aristotle's

[6] See Sedler, and Fine, 1989, for the discussion of the controversy over the interpretation of this last part of the *Phaedo*. Sedler claims that the 'deeper' reading of the eschatological myth closing the *Phaedo* shows that Socrates explanation of the cosmos is teleological. Fine, I think, refutes him decisively.

[7] While introducing the 'sophisticated answer' to the question about causation involving Forms in the *Phaedo* [103e2], Plato uses the word *morphe* as referring to something different from *eidos*. Socrates says: 'It is true about some of these things [like snow or fire] that not only the Form *(eidos)* itself deserves its own name for all time, but there is something else that is not the Form but has its character *(morphe)* whenever it exist' (i.e., for example, fire has the character of hotness). The word *morphe* (here and in other places in Plato's corpus) is usually translated as 'character', while *eidos* is translated usually as the 'Form'. In the above fragment, as Rowe says, '*morphe*, like *eidos*, is used in a special meaning but one which is clearly deducible from the immediate context' and he adds 'both terms usually range between *visible form* and *class*' (p254). On the other hand, Gallop says that the two words, *morphe* and *eidos*, together with the third one, *idea*, seems to be used by Plato 'with no clear distinction' (p236, n72).

In the context of the earlier discussion of Forms as causes, and in particular the distinction that Socrates makes between 'Tollness itself' and 'tollness in us' at [Phdo:102d], some commentators want to see the 'character' as a kind of 'immanent Form' residing in a sensible object and being simply the 'property'of that object. Fine, 1986, p73-80, seems to argue for such an immanentist position, and Nehamas (although his main argument is not for immanentism) says in one place: 'Thus the properties that particulars possess are perfect copies of the Forms in which these particulars participate (p109)'. Dancy, p14-23, however, argues strongly and persuasively, in my opinion, against immanentism of the Forms in the *Phaedo* and other early and middle-period dialogues. In one place he says: 'So we have no right to take Socrates' immanentist language seriously; it is at best metaphorical, and he is telling us that he is not sure what it is metaphorical for. And in the *Symposium* Diotima denies immanence and speaks of participation in the same sentence; she says of the beautiful itself that it will not appear to its contemplator as anything bodily [Symp:211a]'(p15).

In the *Timaeus*, I believe, the interpretation of 'character' can be more strightforward. Plato uses the word *morphai* in two places. First, while discussing the properties of the receptacle, Timaeus says that the receptacle has to be devoid of the characters *(amorphon)* it receives from elsewhere [50d-e]. And in other place, while describing the precosmic receptacle and its agitation [52d], Timaeus talks about the receptacle receiving the

language pertaining to causation, Forms may be considered as formal causes, but whether or not they play the role of efficient causes as well, is not clear.[8]

A causal relation between the Form and the phenomenal particular participating in this Form seems to be different in the two answers that Socrates formulates to the question about the cause of acquiring properties by a particular. The answer to the question: Why is this thing hot? that is formulated 'in the words of the question', [Phdo:105b], i.e., for example that the thing is hot because it participates in the Form of hotness, Socrates calls simple, or naive one. As an alternative, he proposes the other kind of answer that he calls 'sophisticated' or 'clever': the thing is hot because it acquires 'fire', and fire has the essential property of being hot. What 'fire' in this context really is, the Form of fire or some fiery stuff, commentators disagree on.[9] I am inclined to think that 'fire' is a stuff that participates in the Form of hotness and acquires the 'character' of hotness. This interpretation is suggested strongly by Socrates' entire argument; it is the argument about immortality of the soul and the very introduction of the 'clever' answer aims at the final conclusion about the soul. As fire carries with it the character of hotness and withdraws from the body when snow, for example, enters it, such soul carries with it essential property of life and withdraws from the body when death approaches (and there is no Form of soul in the *Phaedo*).

What should be clear from this brief summary of the discussion of Forms in the *Phaedo* is (i) that in the *Phaedo* the role of the Forms in causation is consid-

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morphai of earth and air, and acquiring the properties *(pathe)* that come with these characters. As is evident from the discussion of the geometrical model which follows immediately the discussion of the receptacle where the *morphai* are mentioned, receptacle 'receives' the stereometric bodies which are pure mathematical objects; their shapes may then be seen as 'characters' of the respective mathematical Forms. It is easier, I think, to accept the presence of mathematical structure of tetrahedron in the receptacle than the presence of the character of hotness in fire. Commentators, like Cornford or Gerson, who do not allow for geometrical bodies in the precosmic receptacle consider *morphai* to be 'qualitis' (see my discussion of their position in section 3.4 in Chapter III).

[8] Chang, p24, says yes, and Fine, 1987, p105, says that the Forms are 'E-causally relevant, by being constituents of events', where E stands for 'efficient'.

[9] See the discussion in Gallop, p209-213.

ered solely in the physical world on the terrestrial level, and (ii) that it concerns exclusively the acquisition of some properties by physical objects by way of participating in the Forms. In addition to that, (iii) no intelligent agent is involved in mediation between the Forms and phenomenal objects, for no intelligent agent is envisaged in the *Phaedo* as responsible for causation. It is commonly accepted by commentators that in the first part of the *Parmenides*, Plato criticizes his own approach to causation within the Theory of Forms, as applied in the earlier dialogues. But what the resolution of the problem is is not clear.[10]

2) The Forms as paradigms in the earlier dialogues

As a technical one, the term 'paradigm' in reference to Forms is not a new term just introduced in the *Timaeus*, for it was used in the earlier dialogues like the *Euthyphro* and the *Republic*. The role of paradigm in these earlier dialogues is, however, different from that in the *Timaeus*, as Chang argues.[11] In the *Euthyphro*, Chang says, 'the role of paradigm is conceived as a criterion or standard *in empirical judgment* in term of which other things can be named and evaluated (p85)'. In the *Republic*, for example, it is the Ideal City that plays the role of the paradigm for the philosopher, for he is supposed to recreate this Ideal City. The problem, however, is that, although the philosopher uses the model for his craftsmanship, the relation of what he produces to the model will not be that of the model and the copy, for it is the Form of Justice, rather than the Form of Ideal City that counts in his production. In effect, then, in both the *Euthyphro* and the *Republic*, the paradigm is for the philosopher's contemplation, rather than for making its copy. In addition to that, in the *Republic* at least, the resemblance between the Form and the product of craftsmanship is identical to that which is

[10] See the discussion in Meinwald.

[11] See the discussion in Chang, p85ff.

reached in the act of 'participation', i.e., it is similar to the resemblance between the Form and its manifestation in the particular as considered in the *Phaedo* where the notion of participation is basic. The notion of participation, so prominent in all the middle-period dialogues, disappears completely in the *Timaeus*; it is used neither on the cosmic nor subcosmic levels.[12] The notion of Forms as paradigms in the *Timaeus* also differs significantly from that in the earlier dialogues, as shoud be clear from the discussion below.[13]

3) The Forms in the *Timaeus*: the cosmic level

As I have already observed, the two 'starting points' of Timaeus' account of becoming, which he explicitly signals in the two entries, at [28a] and [48c], begin with the introduction of some specific aspects of the Theory of Forms, and this should already alert us to the fact that the Theory of Forms plays a fundamental role in Timaeus' 'likely story'. The Theory in the *Timaeus* is certainly modified in comparison with that developed and used in the earlier dialogues and this should not surprise us, after his own criticism of the earlier version of the theory in the first part of the *Parmenides*. Although commentators cannot agree how much the theory has been modified we may try to point at a few differences. First of all, in the *Timaeus*, as I see it, the Forms are used in two different ways on two different levels: on the one hand on the cosmic level (macrocosmic and terrestrial), and on the other hand, on microcosmic level. On the cosmic level it is the role of Forms as paradigms for the work of the god that is exploited, and on the microcosmic level it is the imaging of the geometrical Forms of the four elements in the receptacle without god's intervention that is at work.

On the cosmic level the Form of the Living thing is the paradigm for the god

[12]The relevant Greek word, *metezein* is not used in the *Timaeus* at all. See Fujisawa, p42.

[13]The discussion of the role of the Forms in *Timaeus* on the level of the receptacle is continued in section 2 of the next Chapter.

who creates its copy as a living thing. We have, then, on this level two differences to notice in comparison with the earlier dialogues. First, the god is invoked here as the cause, and this is a new feature in comparison with the *Phaedo*. The intelligent agent was absent in the discussion of causation in that dialogue and, as a consequence, the discussion of cosmic generation was abandoned. The second difference is the treatment of the Form of Living Thing as a paradigm. As I have noticed above, the Forms were considered as paradigms also in the earlier dialogues, but the product which the craftsman was producing, while looking at the Form as a model, was never in the relation to the model as that of a copy to the model. Perhaps the reason for this new relation between the model and the product is that in the *Timaeus* the craftsman is divine; he is good and then capable always of doing the best, being limited solely by the material. On the microcosmic level, it is a different aspect of the Theory of Forms that matters, namely the relation between the Forms and their manifestation in phenomenal particulars. This relation in the *Timaeus* is rendered as imaging; in the *Phaedo* this relation on the most elementary level was participation. In the next Chapter, section 2, I will discuss this shift in rendering this most elementary relation.

1.3 The Empedoclean elements as 'auxiliary causes' but not principles of explanation

The god uses the four elements as the material to build the body of the universe [31c-34b]. When ready, the body is interwoven with the soul, forming together in effect 'truly living thing endowed with soul and intelligence' [30c]. The elements are only 'auxiliary causes'[14] for the god, but this specific name for the elements

[14]It seems that the term *sunaitia* rendered as 'auxiliary' or 'accessory' cause Plato uses for the material that is in a ready-to-use form. On the cosmic level the elements are to god's disposition in a ready-to-use form. Similarly, in the third part of the dialogue some body parts are called *sunaitiai*. It is the only other place where the word *sunaitia* is used (besides [46c7] and [46d1]). The secondary gods use these parts as if they were in

as causes is introduced only later on, in the end of the first part of the dialogue. Here Timaeus describes the mechanism of vision using fire as the only element of explanation. After completing this description Timaeus says: 'all of the above are among the auxiliary causes employed in the service of the god as he does his utmost to bring to completion the character of what is most excellent' [46c]. Most people, Timaeus says, identify the four elements as genuine causes, instead as auxiliary ones, for the elements explain changes on terrestrial level satisfactorily. They have fixed properties, and they are able to 'make things cold or hot, compact or disperse them, and produce all sorts of similar effects'[46d]. And people, certainly, err taking auxiliary causes for genuine ones. Philosophers, however, should be immune to this kind of misinterpretation; they should always look for the cause that 'properly possesses understanding' [46d], i.e., soul behind all the changes on the terrestrial level.[15]

The question, certainly, is whether the philosopher will look always for an intelligent cause in changes on the terrestrial level, even granted that in his philosophical reflection on the regularities in the universe he has found the god as its creator. Plato's answer seems to be that even the philosopher who reflected on the

place in their final form. The problem of their coming to be seems to be irrelevant when there is the time to use them. Timaeus says in one place: 'Sinew, skin and bone were interwoven at the ends of our fingers and toes. The mixture of these three was dried out, resulting in the formation of a single stuff, a piece of hard skin, the same in every case. Now these were merely auxiliary causes in its formation - the preeminent cause of its production was the purpose that took account of future generations' [76d]. So, sinew, skin and bone are a ready-to-use material to build 'a piece of hard skin' in order to protect the ends of fingers. Still the word *summetaitia* is used at [46e6] and it is translated similarly as *sunaitia*. This is apparently the only place where this word appears in Plato's dialogues. The word *sunaitia* is used in Plato's other dialogues but only in a few places. See Brandwood, *A Word Index to Plato*, for details. It appears in few places in the *Statesman* [Stat:281c,d,e;287b,c,d;289c] where it refers to the *techne* that produces tools which are subsequently used by another *techne* (identified as a proper *aitia* now) to deliver the final product. The word is translated there as 'contributory cause'; see C.J. Rowe, *Plato: Statesman*. Hankinson writes about the use of of the word *sunaition*: '*Sunaition* becomes a technical term of later Greek causal theory: A is a *sunaition* with B for some effect E just in case A and B both contribute (in some definitions equally) to the E. But it does not have that sense here [i.e. in the *Timaeus*]' (p114,n43).

[15] As I have already noticed earlier, it is the world soul that took over the role of the intelligent agent in the universe when the god had retired [42e], so a philosopher is advised to look for soul as an intelligent cause.

regularities in the cosmos may not be immune to erroneous identification of the elements as genuine causes, for he has Timaeus go on and argue for the compositeness of the elements. Showing that the elements are really composite particles seems to be the only way to convince sceptics that the elements are not principles. But why would Plato think that the philosopher may not be immune to the erroneous interpretation of the elements as principles? I believe that there are two reasons for this possible mistaken identification. First, as Timaeus already noted, the elements explain changes on the terrestrial level very well in terms of opposites: cold/hot, compact/dispersed. In addition, they also serve well as principles of explanation on the cosmic level. As the history of ideas has shown, philosophical reflection of most ancient philosophers always got stuck on one or more of the basic elements as 'principles' in explanation of cosmic phenomena. In fact, the elements as principles also served Timaeus well. He adopted them in the cosmic model just developed: the demiurge uses them in the construction of the cosmos, as if they were principles. And even more, in the fragment under consideration, where he is so preoccupied with convincing his listeners that there is something wrong with treating the four elements as principles of explanation, Timaeus gives us a very convincing description of the mechanism of vision in terms of one of these elements, namely fire.[16] The description is so convincing that it seems that there is no ground for rejecting fire as one of the principles of explanation of phenomena in the physical world.

But it is in this very moment when we would be ready to accept the elements as principles and at the same time as genuine causes that Timaeus says that the four elements are only 'auxiliary' causes. They were auxiliary for the god, and they should be always auxiliary for the philosopher, on both cosmic and terrestrial levels. But how can the philosopher who developed the cosmic model

[16] The interaction between fire from the object and fire from sense organs [45b-46c]. This description will be enriched further on within the geometrical model of becoming where also the mechanism of producing colours will be given [67c-68d].

just presented with the four elements as principles, and who gave a very convincing description of the mechanism of vision in terms of one of the elements, persuade anybody that the elements are not principles? Every one who disagrees with the philosopher may always argue that the model postulating the four elements as principles works well on the terrestrial level, explaining phenomena in terms of opposites, and that he, the philosopher, has just shown that it works well also on the cosmic level. Why, then, does Plato not accept the four elements as principles? The problem, I believe, is that by accepting the four elements as principles we would be left with the entire domain of changes on the terrestrial level still unintelligible. It would be unintelligible in the sense that no intelligent cause could be detected in terrestrial phenomena due to the lack of any mathematical regularities.[17]

To make a unified description of changes on terrestrial level fully intelligible, Plato needs not only Forms of the four elements, but also some involvement of the god. This involvement, Plato decides, should be detectible in the regularities imposed on the existing material by the god. However, because these regularities are accessible neither to our sight, nor to hearing or other senses, the only way to do this is by developing a mathematical model of the elements and show that it works well in explaining a broad range of physical phenomena. Timaeus says that 'most people' treat the four elements as 'principles', as 'letters' of the universe, although 'they shouldn't even be compared to syllables'. The only way to convince people that the elements are not principles is to show that they are composed. Timaeus, then, goes on and in the second part of the dialogue he describes the

[17] The cosmos, as Timaeus has just shown, would still be fully intelligible with the four elements as principles, i.e., as something structureless, for as we have seen, the compositeness of the elements was not an issue on the cosmic level. Similarly as on the cosmic level, the description of becoming on the terrestrial level requires the action of the god who introduces some mathematical order into the seemingly chaotic changes in the physical world. Because of intermutations of the elements the postulate of compositeness of the elements seems natural and the mathematical structure of the elements makes the intermutations intelligible, for with such a structure in place they may be rendered quantitatively.

'intrinsic nature of fire, water, air, and earth prior to the heaven's coming to be as well as the properties they had then' [48b-c].

2. Mathematical Proportion as the Bonding and Organizing Force

The god uses the four Empedoclean elements as the raw material to construct the body of the world. The elements are introduced in this part of the dialogue as structureless entities on which the god imposes the proportion that bonds them together. Timaeus begins his account of the construction of the body of the world with the assertion that because the universe has the bodily form it has to be visible and tangible, and then it has to be composed out of fire and earth [31b]. These two elements are, however, so different that joining them is impossible. Consequently, the god has to use some intermediary material that bonds the air and earth together. The best bond, Timaeus says, is the one that 'really and truly makes a unity of itself together with the things bounded by it, and this in the nature of things is best accomplished by proportion' [31c]. The proportion Timaeus considers as suited for producing a unity is the one between the three entities of which every one may stay either as the first, or the last, or the middle term. In such a proportion all terms 'of necessity turn out to have the same relationship to each other, and, given this, will all be unified' [32a]. An example of such a proportion is the proportion of which one term is a geometrical average of the other two.[18]

Only one middle term in such a proportion would suffice, Timaeus says, if the body of the world were two-dimensional, but because it is three-dimensional, the god needs two middle terms, or in this particular case two materials to connect fire and earth. He uses, then, air and water as 'intermediaries' and makes the four elements 'as proportionate to one another as was possible so that what fire is to

[18] In the domain of numbers an example can be the following proportion: 1:2::2:4. The order of terms in such a proportion can be changed without affecting its validity: 2:1::4:2, or 2:4::1:2.

air, air is to water, and water is to earth' [32b]. An example of such a proportion in a domain of numbers is the so-called continuous proportion (1:2::4:8).[19] The elements bound by such a proportion and used in the construction of the world, made this world 'a symphony of proportion [and they] bestowed friendship upon it, so that, having come together into a unity with itself it could not be undone by anyone but the one who had bound it together' [32c].

There are two problems with this fragment of Timaeus' story: the first one is connected with the entities that Plato would allow as terms of the proportion under discussion, and the second one is the problem of how serious Plato is when he claims that proportion imposed the bond on the four elements. Since both problems are important for my upcoming argument concerning the geometrical model of becoming I will discuss them in some detail.

1) The content of the terms of the proportion

The problem of entities entering the proportion under consideration turns out to be at least partly a linguistic one, and it can be formulated as follows: When Timaeus in his general discussion of proportions introduces the continous proportion in [31c-32a], the one which assures unity, does he exemplify the proportion with numbers only, or does he allow for other entities to be the terms of this proportion as well? Translators are divided on this subject. The newest translation[20] renders the relevant fragment in a way suggesting that only numbers may enter the proportion: 'For whenever of three numbers which are either solids or squares the middle term between any two of them is such that...' [32a]. Both Cornford and Jowett give similar translations; [21] they both refer solely to numbers ('solid'

[19] I call it 'continous proportion' after Prichard, p182, although other names are also used. Cornford uses 'continuous geometrical proportion', while Zeyl in his translation of the *Timaeus* in the *Plato, Complete Works*, p1237, uses the name 'proportionate progression'.

[20] That of Zeyl in *Plato: Complete Works*.

[21] See Jowett's translation of the *Timaeus* in the *Collected Dialogues of Plato*, edited by E. Hamilton and H.

or 'square' numbers), as terms in the proportion under discussion. But in some other translations the proportion is allowed to hold not only for numbers. Taylor, for example, renders the controversial fragment as: 'For when of three integers, or volumes, or characters, the midmost is...' which evidently suggests that entities other than numbers (namely 'volumes', and 'characters') may be considered as terms in the proportion.

Recently Prichard argued persuasively for this broader interpretation of the content of the terms in the proportion under discussion. I will not go into the details of Prichard's argument, but rather summarize his conclusion. The controversial Greek words, which most commentators render as 'solid' or 'square' numbers, and Taylor translate as 'volumes' and 'characters' respectively, are *ogkos* and *dunamis*. Prichard argues that the standard translation is too restrictive and probably wrong, for the continous proportion in general evidently holds not only between the numbers that are cubes ('solids') or squares, but between other numbers as well (like 3:6::12:24), and it holds also between segments of a line, for example. Prichard proposes that the translation of the relevant fragment be close to that of Taylor: 'Whenever among three *arithmoi*, or (for that matter) three bulks or three powers, one is a mean...' (p192). The advantage of this translation, as Prichard himself notices, is that 'we need not postulate a unique sense for any of its terms' (p192), and this, I think, is especially important in the application of the proportion to the four elements: we may think about 'numbers' of elements, their volumes, or their 'powers' (whatever they may be), as being in this particular continous proportion assuring the bonding of elements within the world body.

That we have to look to these more general characteristics of the elements, and not try to link the terms of the proportion with any measures of the geometrical bodies representing the elements, Cornford already indicated.[22] He proposes

Cairns.

[22]Cornford, p51.

total volumes of elements as terms of the proportion being the concern in [32a]. Sayre[23] calls Cornford's proposition 'fanciful conjecture', but he himself is unable to solve the uncertainty of the nature of entities involved in the proportion either. Instead he dismisses the problem as artificial, for he thinks that the need for mean terms between fire and earth is problematic since fire can be connected with earth without intermediary (for tetrahedron can be nested in cube, he says). Sayre concludes that 'all in all, Plato's treatment of fire in this dialogue conveys the sense of being incompletely worked out' (p111,n32). Sayre's criticism of Plato might not have been so categorical if he himself had accepted this broader interpretation of the fragment about proportions, as proposed by Taylor and Prichard. He himself, after all, claims that what makes the four elements commensurate are not so much their geometrical measures as 'certain sensible (not geometrical) features they share among themselves' (p112, n35). If we allow these 'sensible features' to be the 'powers' of [32a], Sayre's interpretation will fit quite well into what Plato says about the proportion between the elements.

The broader interpretation of the content of the terms of the proportion introduced by Timaeus at [32a] is in tune, I believe, with Plato's references to proportions in other places in the *Timaeus* and in some other dialogues. As we may learn from these other references, he considers proportions as a genuine bonding and organizing force in the universe both in physical world as well as in the domain of human affairs, the force which has its beginning in god's activity. In several places in the *Timaeus* Plato has Timaeus indicating clearly that god's main, if not sole, activity is to impose proportions on the material he is dealing with. Because the god is guided by the Form of Living Thing in his construction of the universe we may assume that all these proportions are the part of this unique and peculiar Form. The references to proportions' organizing and bonding properties may also be found in some other dialogues. In the following section

[23] Sayre, 1998; p111, n32.

I will point to some places in the *Timaeus* and in other dialogues where Plato stresses the unique role the proportions play in the universe. In most of those places Plato is rather vague about the exact nature of the proportions he refers to, and does not try to determine them quantitatively (as he does in [32a]), but this does not make them less important in proving my point that proportions in god's hands are Plato's argument against a mechanistic universe.

2) Bonding by proportion: how real is it?

As I have mentioned earlier, in the fragment [31c-32a] Plato introduced the specific mathematical proportion as a bonding force in the body of the world. The kind of proportion Timaeus has in mind is the continous proportion, i.e., the one in which terms may be rearranged in such a way that each of them can occupy any position in the proportion and proportion still is fulfilled. Timaeus claims that in such a proportion the terms 'will all be unified' [32a].[24] The same proportion is used in the construction of the world soul. Here we also have the original mixture not well suited for unification. The three great kinds: Being, Same and Different (still all three in two sorts, 'indivisible' and 'corporeal' [35a]) are not easy to keep together, so the god divides the entire amount of the mixture into pieces; some of these pieces form the continous proportion, i.e., the same as the one used in the construction of the world body, and still other pieces assure that the whole division

[24]It seems that the 'unity' Timaeus is talking about here may be understood in two different ways. In one sense it is the third term which introduces the 'unity' when it is connected with the other two by the proportion: 'there has to be some bond between the two [i.e., earth and fire] that unites them' [31c]. And similarly few lines later: '[the terms in the continous proportion] will all be unified' [32a]. But he also says something that allows us to think about 'unity' differently, namely as the unity of the proportion itself and the terms of the proportion. 'Now the best bond is one that really and truly makes a unity of *itself* together with the things bonded by it, and this in the nature of things is best accomplished by proportion' [31c]. On this second understanding of the unity, the proportion, being a mathematical entity, makes the best unity when it bonds mathematical entities. We may think then about the four elements as truly mathematical objects.

forms the proportions characteristic of the harmonic scale.[25] As in the case of the world body, also now Timaeus mentions explicitly the bonding property of proportions applied in the construction of the world soul [37a]. Perhaps equally important, if not more so, is the harmony produced by the whole operation of division and putting together proportionate pieces.

To the specific bonding feature of proportion Timaeus points still in another way, namely by making an analogy with the bonding power of friendship. After defining the proportion between the four elements, he says that the four elements connected by the continous proportion made the body of the world 'a symphony of proportion [and] they bestowed friendship upon it'[32c]. This reference to friendship here, as a synonym of bonding power, may be seen as an echo of the earlier considerations in the *Gorgias* were we find a similar reference to friendship, orderliness and other virtues that 'hold together heaven and earth', and where we are told that 'proportionate equality has great power among both god and man', and that knowledge of it comes from the study of geometry.[26] The bonding produced by proportions both in the world body and in the world soul, can be, I think, identified with this bonding force which Socrates was looking for and did not find in the *Phaedo*. Here in the *Phaedo*, while criticizing his predecessors, he says: 'but they believe that they will some time discover a stronger and more immortal Atlas to hold everything together more, and thay do not believe that the truly good and *binding* binds and holds them together' [Phdo:99c].

[25] This scale is four and one half octaves long. The procedure starts from the division of mixture into pieces forming the two simple series (1,2,4,8, and 1,3,9,27) and then taken are pieces being the arithmetic and harmonic means within each interval defined by these series separately, e.g. (1,2) or (9,27). The four numbers, the two defining interval and the two being their arithmetic and harmonic means, constitute the continous proportion, the one the god was imposing on the elements, for example 1:4/3=3/2:2, with 4/3 being the harmonic, and 3/2 being the arithmetic mean between 1 and 2.

[26] 'Yes, Callicles, wise man claim that partnership and friendship, orderliness, self-control and justice hold together heaven and earth, and gods, and men, and that is why they call this universe a world order, my friend, and not an undisciplinated world-disorder.... You've failed to notice that proportionate equality has great power among both gods and men, and you suppose that you ought to practice getting the greater share. That's because you neglect geometry' [Gorg:508a].

The proportion introduced as a bonding force into the world body and the world soul affect, first of all, the cosmos as whole. Although we may expect that this bonding will manifest itself also locally, i.e., in the changes in the physical world in any particular region of the cosmos, it is reasonable to expect that these local changes are also influenced by local conditions. As it happens, these local conditions are regulated also by proportions imposed by the god. It is stated clearly at the end of the central part of the dialogue, where we are told that the god imposed on the elements as many proportions as was possible for making them 'commensurable and proportionate'.[27] In this reference to the proportions as means which the god uses to order the precosmos, it is true that the proportion's power of bonding is not mentioned explicitly. However, I believe that Timaeus is very close to it in another place, namely in the fragment [56c]. Here Timaeus says that individual particles are not visible for they are too small, and it is only their aggregates that can be seen. And then he adds that, as to their numbers, motions and powers god imposed on them proportions to the extent that Necessity allowed.[28] These proportions are then imposed locally on the aggregates of particles in order that they may be seen. We should be aware of the fact that the fragment [56c] is already within the geometrical model and visibility within this model is rendered as the result of the interaction of substances, i.e., aggregates of particles, with sense organs. So, to be seen, the particles have to be in aggregates, for this enables them to interact with sense organs. This interaction, we may expect, is enabled by nothing else other than proportions imposed on them; on their numbers, their motions and their powers. Individual particles will not be

[27] 'To repeat what was said at the outset, the things we see were in a condition of disorderlinness when the god introduced as much proportionality into them and in as many ways - making each thing proportional to itself and to other things - as was possible for making them be commensurable and proportionate' [69b].

[28] 'When however, a large number of them [the elementary bodies] are clustered together, we do see them in bulk. And in particular, as to the proportions among their numbers, their motions and their other properties (*dunameis*), we must think that the god had brought them to complete and exact perfection (to the degree that Necessity was willing to comply obediently), he arranged them together proportionately' [56c].

seen for they are unable to interact with the sense organs.[29]

The reference to the powers of proportions as making this world orderly and, by this, intelligible, are present not only in the *Timaeus*, but may be found in other dialogues as well. For example, in the *Philebus* the true mixture of Unlimited and Limit is recognized readily only by detecting in it the presence of proportion. Socrates says: 'That any compound, whatever it be, that does not by some means or other exhibit measure and proportion, is the ruin both of its ingredients and, first and foremost, of itself; what you are bound to get in such cases is no real mixture, but literally a miserable mass of unmixed messiness' [Phlb:64d-e]. And then he adds: 'So now we find that the Good has taken refuge in the character of Beautiful: for the qualities of measure and proportion invariably, I imagine, constitute beauty and excellence' [Phlb:64e]. As this last quotation indicates, Socrates' search for the beautiful and even the good, eventually has been directed toward the search for proportions. And this conclusion seems to be common to late dialogues, for we also find a similar message on the last pages of the *Timeaus* where, while arguing for the effective way of keeping the body and soul in balance, Timaeus says: 'Now all that is good is beautiful, and what is beautiful is not ill-proportioned' [87c].

This turn to proportions as expressing the beautiful and the good should perhaps not be surprising, for the ratio and proportion were always considered by Plato as the basic notions of mathematical sciences and perhaps the dialectic (as a study of Forms) as well. When Plato mathematizes the physical world in the *Timaeus*, we may expect him to turn to these two notions as basic. As some commentators suggest, a mathematical curriculum prescribed in the *Republic* for guardians with the aim of turning their minds away from the world of becoming and toward being, may have been essentially thought out as teaching them to find

[29] At least they are not able to interact with sense organs in the same way as aggregates are. In my interpretation of the precosmos, the stereometric mathematical bodies populating the receptacle do not interact with one another at all.

ratios and proportions in objects of mathematics in order to be able to look for Forms in their study of dialectic, for the Forms may also be ratios or proportions.[30]

3) Conclusions

The broader interpretation of the proportion at [32a], as well as all other references to proportions both internal and external to the *Timaeus*, allow us, I believe, to treat proportion as a genuine 'force' in the universe responsible not only for the bonding of the world soul and the world body as a whole, but also responsible for the clustering of the elements into substances. This clustering, as I will argue in the last Chapter, enables the interaction between the elements and, in effect, is responsible for all changes in the physical world on the terrestrial level. Mathematical proportions are, then, a factor in the world, a factor introduced and controlled by Intelligence; it is introduced by the god and controlled, we may assume, by the world soul, for the soul assumes the control over the world when the god retires [42e]. The force introduced by proportions is, then, a means through which the intelligence marks its presence in the cosmos and counteracts the mechanical forces present in the cosmos as well.[31]

In conclusion, then, we may state two things: first, that when Timaeus defines the unity of the cosmos through the introduction of the proportion in [32a], it is reasonable to assume that he allows for various characteristics of the elements to be the terms of the proportion. Second, that from the abundance of references to the proportions both internal and external to the *Timaeus*, and the contexts in

[30] That Plato's Forms may be ratios is not a new idea (see for example Northrop). Recently Robins, p387-9 and Miller, p83-7 argued that the curriculum of guardians were just designed to look for ratios and proportions in all branches of mathematics in order to be well prepared to recognize Forms in their study of dialectic. Miller (p84) tries to specifically answer the question: *'is it the case that* - analogously as figures are expressed in figured arrays of units and as ratios are expressed in figures - *forms are expressed in and as ratios?'* (italics are author's) and suggests, as does Robins, that the answer may be positive.

[31] As I discuss in the next Chapter, section 4.1, these mechanical forces manifest themselves in the agitation of the receptacle and the drifting motion of the elements into seperate regions.

which they are formulated, we may assume that Plato's position is such that he considers the proportion as a genuine bonding and organizing force in the cosmos as a whole and in the physical world in particular.[32]

[32] Prichard's position seems to be that the bonding property of proportions should not be treated very seriously. His argument for the broader understanding of the terms in the proportion introduced in [32a] is intended as a defense of Plato's position about the unity of the cosmos reached through proportion. His defense, however, is partly based on the suggestion that Plato should not be read very literally here, for, although the whole argument about the continuous proportion between the elements is 'an extraordinary tissue of mathematical sophistry' (p182), we should remember, Prichard says, that Timaeus already announced in [29c] that his account is only a 'likely story', and not a scientific (i.e., mathematical) account. Prichard says that because Timaeus' story is only a likeness of a scientific account it becomes 'a parody of scientific discourse' (p182) and intentionaly formulated 'a piece of playful nonsense' (p192). Prichard clearly exaggerates, for Plato's 'likely story' never was intended as a parody of a 'scientific' method, but rather as an attempt at the most probable account of the physical world that contains so much mathematics as is reasonable for the purpose. It is, certainly, always confusing to claim exact quantitative relations that cannot be readily verified, but fortunately Plato does not confuse us in this way frequently. In fact, the proportion under discussion is perhaps the only one where the exact quantitative relation between the elements is introduced. In all other references to the proportions he is rather vague (in the second part of the dialogue, for example). Of course, there are still exact measures and proportions in the stereometric bodies assigned to the elements within the geometrical model, but these are obvious ones, so introduce no confusion.

III. THE INTELLIGIBILITY OF THE PRECOSMOS

In the first part of the dialogue we are only once confronted with the precosmic state of the universe, i.e., the state prior to god's intervention. We are told here that the god 'took over all that was visible - not at rest but in discordant and disorderly motion - and brought it from a state of disorder to one of order, because he believed that order was in every way better than disorder' [30a]. The second, or central part of the dialogue in its first portion is intended to be an elaboration on this precosmic disorderly state that now is said to be the work of Necessity. In this Chapter I will concentrate exclusively on the content and the mechanics of the precosmos. However, the state of the precosmos has to be considered in conjunction with the alleged god's activity on its content, for unless we identify them concurrently we may misinterpret them both. Unfortunately, Plato's characterization of the precosmos and his remarks about the god's alleged activity on its content are not at all clear, and there is much controversy among commentators about these subjects. What is relatively clear is that the result of the god's work on the content of the precosmos is the geometrical model of becoming. The description of this model and the description of changes in the physical world in terms of this model comprise the bulk of the central part of the dialogue, and they will be the subject of my analysis in the next Chapter. Here, as I have already mentioned, I will concentrate on the precosmos and god's alleged activity on its content. Distinguishing between contribution from Necessity (precosmos), on the one hand, and god's activity, on the other hand, is an important component of every inquiry into becoming, for Timaeus urges the philosopher always to distinguish between the divine and necessary causes; we always search for divine ones for the sake of a happy life, and for necessary ones for the sake of finding the divine [69a].

For the purpose of greater clarity of exposition I shall divide the central part

of the *Timaeus* into five sub-parts; I will refer to them in the body of my essay as they are marked below, i.e., by the capital letters in parentheses. These sub-parts are:

(A) The introductory remarks [47e-48e] where the explanation is given about why we need to study the contribution of Necessity to the formation of the universe and the statements about the compositeness of the four elements.

(B) The description of the theory of Forms as applicable at [48e-52d]. The main task of this description is the introduction of the receptacle.

(C) The description of the precosmic state [52e-53b] with reference to the agitation of the receptacle, motion of its content and brief description of this content.

(D) The presentation of the geometrical model of becoming [53b-68d] which may be divided into two parts: presentation of the model on the microcosmic level [53b-58c] and showing how it works in describing the changes on the terrestrial level [58c-68d].

(E) Concluding remarks [68e-69c] where Plato advises the philosopher to look for divine causes behind the necessary ones and characterizes god's activity as an imposition of various kinds of proportions into the physical world.

The first and last parts, (A) and (E), are introduction to, and summary of, respectively, the whole central part, and I will refer to them frequently in this and the next Chapters. Parts (B) and (C) will be discussed in this Chapter, and part (D) in the next one. I will start this Chapter in the first section with a short discussion of principles and causes valid in the precosmos. Then, in the second section I will discuss part (B). The part (B) is seen by most commentators as referring exclusively to the precosmos, but I interpret it as an elaborate presentation of Plato's Theory of Forms, the Theory that is valid both in the precosmos and in the cosmos. The Theory of Forms as presented in (B) (enriched here by the new principle, the receptacle of becoming) is applicable to becoming on the most ele-

mentary level, namely the level of imaging of the Forms of mathematical objects, and only of them, in the receptacle; in particular the imaging of the four perfect stereometric bodies being the underlying structures of the four Empedoclean elements. These mathematical Forms are imaged spontaneously without any god's intervention. The god instead changes the mathematical world into the physical one by imposing proportions which allow for the interaction and intermutations of the bodies and, as a consequence, a manifestation of phenomenal qualities. I will argue for my position in the third section of this Chapter, where I will also present and criticize positions of other commentators concerning the content of the precosmos. In the fourth and the last section I will address the problem of the Straying Cause; I will argue there that the Straying Cause refers exclusively to the mechanical motion present both in the precosmos and in the cosmos, and it should not be identified with Necessity as a whole, as most commentators assume.

1. The Principles and Causes

In the introductory remarks to the central part of dialogue, i.e., in (A), Timaeus says that he has to give an account 'concerning the things that have come about by Necessity', comparable to that in the first part in which the work of Intellect was his main concern. The reason for this, Timaeus says, is that this world is really 'the offspring of a union of Necessity and Intellect', and this union emerged when Intellect persuaded Necessity 'to direct most of the things that come to be toward what is best' [47e-48a]. The notion of *persuasion* in this context is crucial for the interpretation of the entire central part of the dialogue, and in particular to the interpretation of the precosmic state. The acknowledgment that the god only persuaded Necessity that it direct things that come to be to what is best, is an indication that on the most elementary level of becoming, which is going to be explored in this part of the dialogue, it is Necessity which is to a large extent

responsible for becoming.

The 'best' to which Timaeus refers here is certainly what the god needs for the construction of the cosmos, i.e., the four Empedoclean elements. In the first part of the dialogue we were told that the god imposed a special kind of proportion on these elements, the proportion which introduced the bonding and unity in the cosmos [32a-c]. On the cosmic level the elements looked like the material principles used readily by the god. But at the very beginning of the central part of the dialogue we are told that the elements are not really principles [48a], and they are not principles, for they are composite entities. We will learn soon that they are composite mathematical stereometric objects that may be dissolved into their faces (i.e., elemental triangles) and recombined anew into the same or different stereometric bodies. But we do not need to go into detail about these objects here; this will be the subject of the next Chapter. What is important for our consideration of the precosmos and god's alleged activity on its content is whether or not these stereometric bodies existed already in the precosmos, and in what condition, and whether the god had any say in their construction. The text, unfortunately, is not clear at all in this matter, and commentators are divided on the issue. I claim that the content of the precosmos is mathematical and god's activity on it is to change this mathematical world into a physical one by imposing proportions on it.

What is most striking in this part of the dialogues is that in addition to the intelligent cause introduced on the cosmic level, i.e., the god, Plato allows for the causes that are not intelligent. Plato calls them 'necessary causes', and he has Timaeus at the end of the central part, or (E), urging the philosopher to inquire for both intelligent and necessary causes in every becoming; without the latter, he says, the former could not be found. The notion of necessary causes is new both in comparison with the first part of the dialogue, and generally in Plato's theory

of causation.[33] The relation of the 'necessary causes' to the 'auxiliary causes' (the notion used in the first part of the dialogue) needs some attention. At the end of the central part, after finishing the elaborate description of changes on the terrestrial level in terms of the four elements of which geometrical structure was explicitly used, Timaeus says: 'all these *things* were taken in hand, *their nature being determined then by necessity* in the way we've described, by the craftsman of the most perfect and excellent among things that come to be ... Although he did make use of [these causes as subservient], it was he himself who gave their fair design to all that comes to be' [68e].[34] It is plausible to assume that 'all these *things*' refer here to the elements, so this passage, I think, suggests that the elements are treated in the central part as necessary causes, and that it is clear that their nature has been determined by Necessity. The elements are, then, necessary causes that are subservient to Intellect.[35] Also valid in the precosmos are the three principles of the Theory of Forms: being, becoming, and the receptacle of becoming. I will say more about these three principles just below.

2. The Theory of Forms

The account of becoming in the physical world on the terrestrial level is an undertaking quite independent from that of the genesis of the cosmos, and it is marked by 'the new starting point' [48e]. Similar to the first starting point, which was marking the beginning of the account of the genesis of the cosmos [27d], this new starting point is about the Forms. But it 'needs to be more complex than the earlier one', Timaeus says, and he adds to the two principles, of the Theory of Forms, being and becoming, the third one, the '*receptacle* of becoming - its

[33] There were 'necessary conditions' in the *Phaedo*, [Phdo:99b], but Plato never used the name 'necessary causes'.

[34] In the brackets the translation is according to Cornford as adopted also by Chang, p78; italics mine.

[35] The term 'accessory cause' (*sunaitia*) is not used in the central part of the dialogue at all; see Brandwood, *The Word Index to Plato*.

wetnurse' [49a]. The receptacle is a completely new feature of Plato's Theory of Forms, and its nature, as we learn soon, is rather peculiar. Plato then introduces the receptacle in detail [49b-51b], and subsequently connects it with the other two principles [51b-52d]; these two fragments comprise what I call part (B).

I will first give a brief description of the receptacle and its relation to the other two principles, and then discuss some controversies concerning the interpretation of (B). The interpretation I am proposing, that it is a general elaboration of the theory of Forms in anticipation of the upcoming introduction of the geometrical model of the elements, is not a common one. The prevailing position of commentators is that this fragment deals solely with the precosmic state where no geometrical bodies are present, and should not even be anticipated.[36]

1) The introduction of the receptacle

Timaeus decides that the best way of introducing the receptacle is through the discussion of 'preliminary problem about fire and the other three' [49b]. This 'preliminary problem' concerns the reliability of referring to the four elements, and perhaps even stability of the elements themselves.[37] Since we see the elements changing into one another in cycles by dissolving, dispersing and condensing, Timaeus says, we should refer to none of them by 'this' or 'that', but rather talk about every appearance of each of the elements safely by 'what is such'.[38] Referring to something by 'this' or 'that', Timaeus continues, indicates always 'designating something', and suggesting stability. But the elements are not stable, for they are only temporal appearances in the receptacle. It is solely the receptacle that may be referred to by 'this' or 'that', for it is the only entity with permanent existence. Timaeus says: 'that *in* which they [i.e., the elements] each appear to

[36] This is position of Cornford, p180, n1, and those who, one way or another, follow him.

[37] See the discussion in Hunt.

[38] As we learn soon, it is the part of the receptacle that is 'such', i.e, 'fiery' or 'watery'.

keep coming into being and *from* which they subsequently pass out of being, *that's* the only thing to refer to by means of the expressions *that* and *this*. A thing that is some 'such' or other, however, - hot or white, say, or any one of the opposites, and all things constituted by these - should be called none of these things [i.e., *this* or *that*] [49e-50a]'.

These preliminary considerations about the relation between the receptacle and the elements tell us that the elements are appearances in the receptacle and in every exact description of changes in the physical world, i.e., the description of these cyclic intermutations of the elements, we should refer directly to the receptacle, rather than to the appearances: when a part of the receptacle 'gets ignited [it] appears on each occasion as fire, the dampenedd part as water, and parts as earth or air insofar as it receives the imitations of these' [51b]. In other words, we should not use simple designates like 'fire' or 'water' but instead refer to a 'fiery' or 'watery' part of the receptacle. This certainly would be a very inconvenient way of describing changes, so Timaeus abandons it immediately after completing this formal introduction of the receptacle. Already in his description of the precosmos in (C), and obviously in his description of changes within the geometrical model in (D), he refers to 'appearances' in the receptacle simply by their names: fire, air, water, and earth. The point, however, was made here that on this very elementary level of considerations, the elements 'are coming into being' in the receptacle and 'subsequently pass out of being' from the receptacle; without the receptacle becoming on this very elementary level would not be possible and the description of intermutations of the elements would be unintelligible.

But the discussion of the 'preliminary problem about fire' neither taught us about the properties of the receptacle, nor referred it to the other two principles of the Theory of Forms, i.e., being and becoming, or more precisely, to the Forms and their images. Both topics are addressed immediately after the discussion of the 'preliminary problem about fire', and they are addressed in very general terms,

with no explicit reference to fire or to any other element. And it is what we learn about the receptacle as such: it is a rather peculiar entity, for although it is 'this', it is essentially an 'invisible and characterless sort of thing' [51b], 'devoid of any inherent characteristic of its own' [51a], and it does not have its 'own face' [50e]. The reason it is characterless is that it has to be able 'to receive in itself all the elemental kinds' [50e], or 'all the bodies' [50b]. While receiving these external 'kinds' or 'bodies', it does not take on any characteristic of these things [50b]; it is true that 'it is modified, shaped and reshaped by the things that enter it' [50c], but on the other hand, its nature remains unchanged. The reference to the 'elemental kinds', and even 'bodies', is a clear indication that the discussion here is in the anticipation of the upcoming introduction of the geometrical model. Evidently the elements in the geometrical model are 'bodies', namely the stereometric figures which 'shape and reshape' the receptacle, while undergoing intermutations.

What were 'appearances' of fire or water in the preliminary discussion are now generally referred to as 'imitations (*mimeata*) of those things that always are', [50c], or 'likenesses of the intelligible objects' [51a]. Of course these 'intelligible objects' may only be Forms, and Plato names explicitly the Form of fire and indicates the existence of the Forms of 'other things' (i.e., other elements) immediately after finishing his elaboration on the receptacle [51c]. The Forms are referred to in a standard way as 'things that always are' [50e, 51a], or as the 'source of [things'] coming to be' [50d]. That the phenomenon of instantiation of images of the Forms in the receptacle is perplexing, Plato acknowledges explicitly in this part of the dialogue.[39]

[39] And he does it twice. In one place he says that images are imprinted in the receptacle 'in a marvelous way that is hard to describe' [50c], and in the other place he says that the receptacle 'receives all things and shares in a most perplexing way in what is intelligible, a thing extremely difficult to comprehend' [51b]. This perplexity, I think, may be seen as an indication that the instantiation of the stereometric bodies in the receptacle is a spontaneous process, rather then the process mediated by the god. If the god had any part in it, I think, it would have been explicitly stated, or at least indicated in this part of the dialogue. The instantiation of the stereometric bodies mediated by the god would not need to be perplexing.

2) The relations between the three principles of the Theory of Forms

Having elaborated on the nature of the receptacle, Timaeus relates this new entity to the other two principles of the Theory of Forms [52a-d]. But first he introduces explicitly the Forms of the elements and invokes once more the basic distinction between being and becoming. 'Is there such a thing as Fire by itself?', and does the 'intelligible Form for each thing' exist?, Timaeus asks, and 'votes' for the following answer: 'If understanding and true opinion are distinct, then, these *by themselves* things definitely exist - these Forms, the objects not of our sense perception, but of our understanding only' [51b-d]. So the Forms, or at least the Forms of the elements in this context, are one thing. The second thing is derivative from the first one, and it 'shares the other's name and resembles it' [52a]. It is becoming in a certain place and perishing later, and it is not apprehended by reason, but only by opinion. The third thing is the 'space'; it exists always and can be apprehended by a kind of 'bastard reasoning' [52b]. The thing that is 'by itself' is the one which 'really is' and it can 'get support' from the true account. This thing is distinct from the image, so the image that is 'invariably borne along to picture [it]' has to 'come to be in something else, somehow clinging to being, or else be nothing at all' [52c]. This 'something else' is the receptacle.

The elaboration on the relation of the three principles of the Theory of Forms, together with the preceding detailed introduction of the receptacle, is one of the most extensive expositions of the Theory, readily comparable to that in the *Phaedo*. There are obvious differences in treating the Forms in these two dialogues, and I have already mentioned some of them, while discussing the paradigmatic approach to the Forms on the cosmic level. Here I would like to point out some other differences related to the introduction of the receptacle. In the *Phaedo* the Forms, or rather participation in them by phenomenal particulars, are the causes

of acquiring by these particulars some properties. The causation in the *Phaedo* is then considered in the physical world on the terrestrial level, i.e., macroscopically. On this macroscopic level in the *Timaeus* the 'properties' of physical objects as well as changes in the physical world and sensations will all be rendered in terms of the geometrical model of becoming that is under development in the central part of the dialogue, and the Forms will never be mentioned explicitly in this description of the physical world, for the simple reason that they will be unnecessary. In my interpretation, the geometrical model, which I discuss in the next Chapter, has two components: the geometrical structure of the particles of the four elements and the dynamics responsible for the interaction between the physical objects. The structure of the particles, I will claim, is purely mathematical and perfect and requires no god's intervention, while the dynamics, i.e., physics, originates in god's imposition of proportions on these mathematical stereometric bodies. I see these proportions as representing the Forms of the four elements, for they determine the behaviour of the stereometric bodies and by this define what the elements are. Particular proportions corresponding, for example, to the Form of fire are imposed on the aggregates of mathematical objects that are tetrahedra and the aggregate of such objects will then be identified macroscopically as fire, for it will interact with sense organs in a specific way characteristic of fire, i.e., it will produce the sensation of hotness. While the imposition of the particular proportions on the aggregates of mathematical particles (the imposition, for example, of the Form of fire on the aggregates of mathematical tetrahedra) is the work of the god, the instantiation of the stereometric mathematical bodies in the receptacle is the 'work' of the relevant mathematical Forms and is essentially

random.[40]

Within the geometrical model, the problem which was crucial in the *Phaedo*, i.e., the problem of 'participation', or more generally the problem of relation of phenomenal particulars to the Form, is absent in the *Timaeus*. In the *Timaeus* there is nothing like a 'property' or 'quality' of a physical object existing in this object; the properties of physical objects are functions of the interaction between the objects and sense organs, and this interaction is determined by the Forms of the elements, i.e., by the mathematical proportions. The physical object does not need to 'participate' in the Forms in order to acquire its particular properties. But the difficulty which the notion of 'participation' created in the *Phaedo* has not disappeared completely with the introduction of the receptacle in the *Timaeus*. It emerges in the *Timaeus* on the microcosmic level in the notion of 'imaging' of mathematical Forms in the receptacle, the notion that seems to be not less perplexing than the notion of 'participation' in the *Phaedo*.[41] Some commentators still insist on analyzing the imaging in the receptacle in the language of participation.[42]

The images in the receptacle, which I take to be the images of the stereometric figures, are the images of the mathematical Forms, and these Forms I understand as causes of their images. There is resistance on the part of some commentators

[40]It is not plausible, I believe, to assume that the god causes the instantiation of mathematical object. If he does, then, following the scheme of the generation of mathematical objects as present in the *Parmenides*, we would have problems with properly placing his intervention in the mathematical world, for obviously the god is not One. See Chapter IV, section 2.2 for a brief discussion of the problem of generation of mathematical entities in the *Parmenides*.

[41]Compare the reference about mystery of participation in the *Phaedo* [100d], with those about perplexity concerning imaging in the receptacle present at [50c, 51b].

[42]In his recent discussion of the *Timaeus* Sayre, 1998, p108-13, considers three candidates for participation in the Forms. He rejects the two: the receptacle and what he finds in [32c5] as ' *whole of each of the four [elements]* ... caught up in the creation of the world or perhaps some subset of these at some stage of formation' (p110). He accepts as participating in the Forms what he finds in [50a] as 'qualities with contraries, such as hot and white, along with everything compounded of such qualities' (p111). Plato abandons, however, the use of the word 'participation' (*metexein*) in the *Timaeus* completely. See Fujisawa, p42, on this problem.

to consider the Forms in the *Timaeus* as causes, even on this microcosmic level of the receptacle, for nowhere in the *Timaeus* does Plato call the Forms causes. There is, however, one place in the dialogue which suggests that perhaps Plato did not abandon the notion of the Forms as causes after all, even if he did not call the Forms explicitly the *aitiai*. This place is in Timaeus' elaborate description of the receptacle where he refers to Form as 'father',[43] in the same way as he referred to the god when in the first part of dialogue he called him 'a father' and also the cause of the universe. So, we may say, that on this very elementary level of becoming, on the level of imaging of the Forms in the receptacle, the Forms may, after all, play the role of causes, i.e., the role assigned to them in the *Phaedo*.[44]

When the god constructs the universe and uses the Forms as paradigms, he is commonly identified as the efficient cause, and also as the final cause of the image he is producing, while the Forms are seen as formal causes (if the Forms are still considered as causes). The material he is using is then identified as the material cause. If we try to apply this Aristotelien language of causation to the imaging of the mathematical Forms in the receptacle without god's intervention, we will definitely miss the efficient cause.[45] But I believe that in the analysis of causa-

[43]'For the moment, we need to keep in mind three types of things: that which comes to be, that in which it comes to be, and that after which the thing coming to be is modeled, and which is the source of its coming to be. It is in fact appropriate to compare the receiving thing to a mother, the source to a father, and the nature between them to their offspring' [50d].

[44]In the *Phaedo* the notion of participation was rather obscure, so the causal relation between the Form and phenomenal particulars was not clear. It was evidently not clear within so called 'simple answer' to the question about causation, even after the introduction of the notion of the 'character' corresponding to the given Form and residing in a phenomenal object. The understanding of the causal relation between the Form and a phenomenal object does not improve much within so called 'clever' answers to the questions about causation, for the 'fire' that brings hotness to the body still has to participate, one way or another, in the Form of hotness. In the *Timaeus* the problem of 'acquiring the qualities' by phenomenal objects is formulated as the problem of interaction between the objects and sense organs and solved within the geometrical model of physical world.

[45]Gill refers to the imaging of what she calls 'ultimate simples' in the receptacle without god's intervention 'formal causation'; see the more complete discussion of her position in section 3.3, part 2) of this Chapter. Strange, says that Necessity, which produces traces of the elements in the receptacle, 'involves Forms in the same way the *clever aitiai* of the *Phaedo* do' (p33).

tion in the *Timaeus* we need not be preoccupied with the Aristotelian language of causation, for in neither the *Phaedo* nor in the *Timaeus* does Plato give any hint that he was influenced by Aristotle in this matter.[46] I believe that the only explicitly mentioned Forms: the Form of Living Thing and the Forms of the four elements,[47] refer to the paradigmatic Forms which god uses in his construction of the cosmos. This 'fire by itself' on my interpretation consists of a particular shape of the particles of fire and particular mathematical proportions defining their interactions with other elements and producing effects called by us, observers to be the 'properties' or 'qualities' of substances. The god copies this 'fire by itself' by imposing these proportions on the stereometric bodies being present already in the receptacle. These stereometric bodies were instantiated there by relevant mathematical Forms. About these mathematical Forms Plato says nothing in the *Timaeus* and for this reason the Forms are never considered here as the causes of the physical world.[48]

3) Against treating part (B) as referring to the precosmos solely

The fragment under discussion, (B), which I consider to be an elaboration of Plato's Theory of the Forms as applicable in the *Timaeus* on the microcosmic level, and valid in both the precosmic and cosmic states, is nested at the beginning

[46] But Plato seems to be distinguishing between *aitia* and *aition*. As Ledbetter argues, in the *Timaeus*, Plato uses only *aitia* and never *aition* to describe the demiurge's reason or grounds. Both words are used interchangeably to name non-teleological causes.

[47] The 'fire by itself' and 'an intelligible Form for each thing' [51b-c], where 'each thing' most probably refers to the four elements.

[48] The mathematical object may also be created due to the power emanating from One (as indicated in the *Parmenides*; see my brief discussion of this problem in Chapter IV, section 2.2), if not caused by the relevant mathematical Forms. Still one comment on the terminology: by 'the Forms of the elements' I understand the paradigmatic Forms of 'fire by itself' and similarly for other elements. I will use frequently the expression 'the elements' or 'the four elements' as referring to the pure mathematical objects, i.e., the four stereometric bodies as far as precosmic state is concerned, but I will understand them as referring to physical particles, i.e., as objects capable of interacting in the cosmic state.

of the discussion of the work of Necessity, and it precedes an elaborate description of the geometrical model, which evidently is a model concerning the cosmic state of the universe. Already this specific placing of the fragment prompts some commentators to consider (B) as referring to the precosmos solely. These commentators find additional support for their stand in the fact that (B) begins and ends with the clear references to the precosmos (in [48d] and 52d], respectively).[49] The setting of the fragment and these two explicit references to the precosmos are, then, used by some commentators as arguments for treating (B) as concerning the precosmos exclusively. While I agree that (B) concerns the precosmos, I cannot agree that (B) concerns it solely; I believe that it concerns the cosmos as well, for in my view it is an elaboration of Plato's Theory of Forms, a theory which certainly is valid in both states of the universe.

The controversy over the proper interpretation of (B) and its relevance for the cosmos cannot be resolved definitely[50] but I want to formulate some arguments

[49]In the introductory reference Timaeus says: 'we shall of course have to study the intrinsic nature of fire water air and earth prior to the heaven's coming to be, as well as the properties they had then' [48b]; and in the concluding remarks Timaeus says: 'Let this, then, be a summary of the account I would offer as computed by my *vote*. There are being, space, and becoming, three distinct things which existed *even* before the universe came to be' [52d].

[50]As I said, commentators are divided about how to treat (B). Gerson, p43, for example says: 'That a precosmic state is the focus of the discussion is emphasized at two points, [48b3] and [52d2]', i.e. the two entries I have discussed already. Lee, p352, invoking support from Aristotle, claims that (B) is not used in the rest of the dialogue. He also believes that agitation of the receptacle mentioned in [52e] and [57c] excludes (B) from both the precosmos and the cosmos. On the other hand, however, some commentators see the connection between (B) and other parts of the dialogue. Hunt, p77, considers (B) as applying to both the precosmos and the cosmos as well. Hunt, p77, for example, claims that (B) and even (C) cannot be solely about the precosmos for Timaeus talks about the 'visibility' and 'perceivability' [51a,52e] of the appearances, and this evidently implies the involvment of sense perception, and in consequence, the cosmic stage. This, however, I do not see as a strong argument, for Timaeus evidently is not very strict in this respect. In [30a] he also says that the god took 'what was visible', although he evidently refers here to the precosmos. (Perhaps this precosmic 'visibility' should be understood as visibility to the god, and not as ordinary visibility involving senses.) White, p327, although with hesitation, opts for the 'relevance' of (B) for the rest of the dialogue. Gill, p48 also allows for the connection of (B) with other parts of the dialogue, but she considers it to be describing the precosmos solely, and she thinks that 'the receptacle is not relevant to the construction of physical bodies'. The strong connection between (B) and the geometrical model is noticed, however, by Morrow, 1968, p12, who thinks that the Theory of Forms (as developed

against those who treat (B) as referring to the precosmos only. (i) First of all, the two references to the precosmos, one at the beginning of the fragment, and the other one at its end, do not need to be interpreted as an indication that the fragment is solely about the precosmos. Plato is just saying that we have to study the precosmos as well as the cosmos, for becoming was the process occurring in the precosmos, as it is in the cosmos. And it was occurring because the three principles of the Theory of Forms were existing *'even* before the universe came to be' [52d]; certainly they are operating in the cosmic state as well. (ii) Second, it is true that the fragment (B) is nested at the beginning of the description of the work of Necessity, but this description also contains an elaborate description of the geometrical model, which has clear god's input. The fragment (B) is followed immediately by (C) which evidently concerns the precosmos, and then by (D) which is about the geometrical model; in both of these fragments we find references to (B); and they would not be intelligible without (B).[51] Altogether, it is then plausible to assume that (B) concerns both the precosmos and the cosmos, for it is about Forms, obviously eternal beings, and how they are related to the physical world. (iii) Third, I believe that restricting (B) to the precosmos only introduces many interpretative problems in (B), for in it Timaeus evidently uses language which fits perfectly the forthcoming discussion of the geometrical model (like *mimemata, somata*); these inerpretative problems will be evident in the next section where I discuss Gerson's position. (iv) Fourth, I believe that, without the discussion of becoming in (B), where we are clearly instructed about the relation between images in the receptacle, and the receptacle itself, the geometrical model could be understood erroneously; we would be entitled to count the volumes of the stereometric bodies as representing the 'masses' of the elements and scold Plato for wrong arithmetic, which he applies in his 'chemical reactions', for he uses there

in (B)) furnishes the 'logical foundation' of the geometrical model.

[51] I think here first of all about references to the receptacle in both parts.

the arithmetic involving faces, rather than the arithmetic involving volumes, and for us it would be more 'natural' to use the arithmetic of volumes.

3. The Content of the Precosmic Receptacle

The content of the precosmic receptacle and its dynamical state is essentially described in the fragment [52d-53c], or (C), but certainly the process of becoming in the precosmic receptacle is exactly as described within the Theory of Forms elaborated in (B). In this section I will confine myself exclusively to the discussion of the content of the precosmos, leaving its dynamics to the next one. In my analysis I will take into account Timaeus' direct statements about the precosmos, but also his utterances about god's alleged activity, which are found mainly in (E). For clarity of exposition I will divide the relevant references into two categories: the first category comprises the references to the state of the precosmos; and the second, to god's alleged activity.

The state of the elements in the precosmos is rendered in the following way:
(1) 'the four kinds all lacked proportion and measure' [53b]
(2) 'at the time the ordering of the universe was undertaken, fire water, earth, and air initially possessed certain traces of what they are now' [53b]
(3) 'they were indeed in the condition one would expect thoroughly god-forsaken things to be in' and this was their 'natural condition' [53b]
(4) '[f]or at that time they had no proportionality at all, except by chance' [69b]
(5) 'nor did any of them qualify at all for the names we now use to name them like *fire, water,* etc.' [69b]

God's activity is described as follows:

(a) 'the first thing the god then did was to give them [i.e. the four elements] their distinctive shapes, using forms and numbers' [53b]

(b) 'the god fashioned these four kinds to be as perfect and excellent as possible when they were not so before' [53b]

(c) 'And so all these things were taken in hand, their natures being determined then by necessity in the way we've described, by the craftsman of the most perfect and excellent among things that come to be... Although he did make use of [causes of this order as subservient], it was he himself who gave their fair design to all that comes to be' [68e].[52]

(d) 'the things we see were in a condition of disorderliness when the god introduced as much proportionality into them and in as many ways - making each thing proportional both to itself and to the other things - as was possible for making them be commensurable and proportionate' [69b]

(e) '[a]ll these things [the four elements], rather, the god first gave order to, and then out of them he proceeded to construct the universe' [69c]

(f) 'as to the proportions among their numbers, their motions, and their other properties (*dunameis*), we must think that [the god] arranged them together proportionately' [56c]

There is a great deal of controversy over the interpretation of these passages. I will divide into two groups those who comment on them: In the first group I place those who claim that the content of the precosmic receptacle is 'qualities' and the god's intervention amounts to the imposition of geometrical Forms on these qualities. The position of the second group is that the content of the receptacle is geometrical objects; some commentators think that it is geometrical bodies, which are degenerate, and god's work is to make them as perfect as possible, and use them in the instantiation of the images of 'higher Forms'. Others believe that the original content of the cosmos is more basic geometrical structures. I will discuss more comprehensively the positions of some commentators later on, but first I

[52] In the brackets the translation is according to Cornford as adopted also by Chang, p78.

will present my position on the content of the precosmos and alleged god's activity, and argue that it is consistent with the above quotations (1)-(5) and (a)-(f).

3.1 The content is perfect stereometric mathematical bodies: my interpretation

My position is that the geometrical bodies in the precosmos are pure mathematical structures for they are images of the Forms of stereometric bodies. These mathematical structures are entities that do not interact with one another. God's activity amounts to the introduction of many kinds of proportions [32a,56c] and these proportions transform mathematical structures into physical elements. These physical elements are, first of all, enabled to interact and this interaction is, in my interpretation, the exclusive property of aggregates of the particles, rather than of individual particles.[53] In what follows I will show that the statements about the state of the precosmos, (1)-(5), and the ones about god's alleged activity, (a)-(f), listed above are consistent with my interpretation of the content of the precosmic receptacle. In particular I will argue that the above statements about god's activity may be interpreted as saying that the imposition of the proportions within the given kinds of elements, and between the different kinds is the only activity of god's envisaged by Plato, and that these proportions transform mathematical entities of the precosmos into the physical particles of the cosmos.[54] While arguing for a particular interpretation of this or that fragment we should have in mind what Timaeus said at the very beginning of his 'likely story', namely that he will not be able to produce 'an account on many subjects - on gods or

[53]That this is how Timaeus describes the interaction within the geometrical model, I will argue in the next Chapter.

[54]Showing consistency and arguing that the proposed interpretation is better than the rival ones, for it avoids difficulties inherent in them, is essentially all one can accomplish, for due to the vagueness of the the text concerning the precosmos, these rival interpretations are also 'consistent' with the text. While arguing for his own position, Gerson, for example, says about the interpretation of the precosmos as containing the geometrical bodies: 'I admit that his is a possible interpretation, but I would strongly urge that it is not a necessary one. As we shall see, it fits badly with a more comprehensive interpretation of the *Timaeus*', p48-9.

the coming to be of the universe - that is completely and perfectly consistent and accurate' [29c]. And here are my arguments:

(I) I think that it is plausible to assume that on the most elementary level, that of imaging of the Forms in the receptacle, the instantiation of these images is spontaneous, and no god's intervention in this process is required. This assumption is strongly supported by the description of becoming within the theory of Forms in (B) where I identify three things pointing to such an interpretation. (i) First, the god is completely absent from (B); if he played any role in instantiating of the Forms of stereometric bodies in the receptacle similar to his role as a craftsman of the cosmos (as some commentators think he did) his absence in (B) would be surprising. (ii) The second thing is that Timaeus explicitly states in two places that the instantiation of images of the Forms in the receptacle is a rather perplexing process [50c,51d]. I think that if it were the god who caused the instantiation of the images in the receptacle, the process would not be as perplexing as Timaeus says. After all, the construction of the macrocosmos, when the god is copying the Form of the Living Thing, is never presented as perplexing. The instantiation of the geometrical bodies in the receptacle is difficult to explain because the Forms are the only causes of this process, and the relation between the Forms and particulars was always perplexing, even in the *Phaedo* [100d]. That Forms may be seen as causes of their images in the receptacle, I argued earlier.[55]

(II) Timaeus begins the description of the precosmos in (C) as follows: when the characters of the elements enter the receptacle, the receptacle acquires properties coming with these characters and takes on a variety of visible properties [52d-c]. On the face of it, this fragment, as the description of the precosmos, does not fit well my interpretation of the precosmos, for I envisage in the precosmos

[55] See part 2) in section 2 of this Chapter.

geometrical bodies which essentially do not interact, and I also claim that it is the interaction between the elements that leads to the manifestation of phenomenal properties. No properties, or visible aspects of the elements, should then be found in the precosmic receptacle. One way out of this difficulty,[56] I believe, is by noticing that what Timaeus says about the precosmic receptacle here, at the beginning [52d-e], is weakened significantly by his later statements about the precosmos. A few lines later we learn that there were only traces of the elements in the precosmic receptacle (2), and that the elements possesed proportionality by chance only (4), and they did not deserve the name we now give to them (5). These negative characteristics of the content of the precosmos fit my interpretation well. The geometrical particles in the precosmic receptacle, in my interpretation, existed as individual particles; they were without the proportions that the god imposed on them only later, proportions which clustered them and allowed them to interact and display phenomenal qualities. By chance, however, there may have been formed in the precosmos the aggregates of particles that could have the ability to interact, and in consequence produce phenomenal qualities; these aggregates were, however, only the 'traces of what they are now' for the aggregates were very ephemeral entities in the receptacle because they were clustered by no specific proportions.

(III) The most detrimental point with regard to my interpretation seems to be the statement (a) in combination with the statement that the god made the elements proportional 'to itself' (d). In contrast, of course, both of these statements serve well those who claim that god's activity was to impose geometrical

[56] There is still the other possibility to argue, namely that Timaeus is not very strict about referring to sensations in the precosmos. Here we are told that the receptacle 'takes on variety of visible aspects' [52e], and in the first part of the dialogue he said that the god 'took over all what was visible' [30a]. I think that both fragments should be taken as references to material things that have the capacity to be perceived. The references are in both cases to the content of the receptacle, the mathematical stereometric bodies that will be visible in a proper sense when perceivers will be ready to perceive them.

Forms on the precosmic 'qualities'.[57] I believe that making a thing proportional 'to itself' may well refer not so much to individual particles,[58] but rather to the particular kind of particles. That this is a plausible assumption is indicated by the fact that in (a) and (d) Timaeus refers to the elements as *things*, or by their names but never as particles or bodies (*somata*). If I am right, then, there exists many ways of making the given kinds of particles proportional 'to itself'. First of all, in the description of the geometrical model Plato tells us that the individual geometrical bodies are too small to be visible, and because of this clusters have to be formed [56c]. The forming of clusters of particles of a given kind evidently can be interpreted as making 'each *thing* proportional ... to itself'.

The other occasion for the god to make 'each thing proportional ... to itself' emerged when he was deciding about the different grains of the particles of the same kind. It is plausible to assume from the requirement of maximum proportionality that these different sizes are commensurable, for then the proportions could have been imposed on them. By 'requirement of maximum proportionality' I understand Timaeus' statement formulated in (d), namely that the 'god introduced as much proportionality into them and in so many ways ... as was possible for making them be commensurable and proportionate'.

(IV) While everyone commenting on the precosmos notices the fragment (a) and interprets it according to the model of the precosmos he prefers, the other important fragment for the correct interpretation of the precosmos is usually over-

[57] Mohr, who also allows for the geometrical bodies in the precosmic receptacle, except that imperfect ones, argues strongly against interpreting (a) as stating that the god imposed forms and numbers on the unstructured precosmic content. He says that (a) should rather be understood as the god doing the 'alterations with respect to number' (p111). He himself, however, understands these alterations as transforming the imperfect images into perfect ones, and this is for him 'making each things proportional ... to itself'. While I accept Mohr's criticism of interpreting (a) as imposing the geometrical Forms on formless content of the receptacle, I am against interpreting (a) and (d) as correcting the shapes of each particle that happens to be imaged imperfectly in the receptacle.

[58] As Mohr thinks; see the proceeding footnote and the more detail discussion of Mohr's position in the following section.

looked. I am thinking about the fragment (c) where we are told that 'all these *things* being so constituted of necessity'. This fragment, I believe, gives strong support for establishing my point about the precosmos. It is the beginning of the summary at the end of the central part of the dialogue, and Timaeus has just finished the description of substances, their properties, and the way they are perceived by the senses. In this context, then, it is plausible to assume that the statement 'all these *things*' most probably refers to the elements. The elements, we are told, have 'their nature determined by necessity', and the god took them and used for his purpose, namely creation the physical world, the one modelled on the Form of Living Thing. We are told in these concluding paragraphs of the central part of the *Timaeus*, that the god imposed as many kinds of proportions as was necessary for making the content 'commensurable and proportionate'. We may assume that these proportions were those the god had found in the model of Living Thing, for the perfect stereometric bodies were already populating the receptacle, and no perfection of them was necessary. It is interesting to notice that the elements are no longer called here the 'auxiliary causes', but rather they are simply 'causes', although subservient to the god.

In conclusion, then, it seems that all of the statements about the content of the precosmos, as well as the statements about god's activity, are consistent with the model of the precosmos populated with the perfect geometrical bodies which are instantiated in the receptacle without god's intervention. These bodies, in my interpretation, do not interact with one another, for they are capable of so doing only after the imposition of proportions on them by the god. These interactions will lead eventually to the manifestation of phenomenal qualities of physical objects.

3.2 The content is imperfect bodies: Mohr

The model of the precosmos, similar to that discussed above, but with the imperfect geometrical bodies in the precosmic receptacle and with the god making them perfect was proposed a long time ago, but from the time of Cornford's attack on it, it lost popularity for some time; it seems that recently it has again found adherents.[59] I will concentrate in this section on the criticism of Mohr's model, for his is the most developed one. The other models accepting the geometrical objects in the receptacle are discussed in the next section.

Against Mohr:[60] the god does not perfect individual particles.

Crombie[61] proposes the 'imperfect' geometrical bodies as the content of the precosmic receptacle in a very peculiar way. He suggests that because the receptacle ('space') existed in the precosmos there was genesis in the precosmos as well, although it was sporadic at that time. But Crombie did not think that geometrical bodies were formed in the receptacle, but rather that it was the receptacle that was 'forming itself irregularly into rough triangles' which in turn from time to time 'form[ed] crude approximations to regular solids' (p220). These 'approximations' Crombie calls 'embrionic forms' of the elements (p219), and he connects with them 'rudimentary occurrences of the properties which the elements are to have when the ordering work is done' (p219).

[59] According to Mohr, 1985, p118, n16, it was Baumker, who proposed such a model at the end of the last century. Cornford attacked it so it fell into disfavor for a long time. But already Morrow, 1950 allows for geometrical objects in the receptacle. Crombie proposed that it is the receptacle itself that undergoes geometrical structuring. Recently Mohr, 1985 developed the model most fully and Strange adheres to his notion of imperfect geometrical bodies as residing in the precosmic receptacle. I concentrate primarily on the criticism of Mohr's model.

[60] Mohr, 1985, Ch.5.

[61] Crombie, p219-20.

Mohr's model of the precosmos is the one in which genuine geometrical bodies are instantiated in the receptacle (1985, Ch.5). These geometrical 'particles', as he calls the elements, 'frequently deviate from the perfect regular solids described in [53c ff]' as geometrical shapes of the elements. The role of the god, Mohr continues, is 'to bring deviate particles into accord with their paradigmatic Forms by eliminating any degree to which they fall away from their paradigmatic Forms, thus making them perfect instances of their corresponding Forms' (p108). Mohr argues against those who see in the precosmic receptacle 'qualities' or a kind of formless matter.[62] I subscribe to this criticism, but I shall criticize Mohr's interpretation that the geometrical bodies are imperfect. Mohr certainly relies on the same set of references in the *Timaeus* to the precosmos and god's activity that I was relying on while arguing for my interpretation of the precosmos, but he interprets them differently. Below I formulate some objections to Mohr's interpretation, and in this discussion I refer to the quotations (1)-(5), and (a)-(f) collected at the beginning of section 3.[63]

(i) In his interpretation of (1), (4), and (d) Mohr (p109) refers to the *Statesman*[64] where, he says, is formulated 'Plato's theory of relation of measure to artistic production'. The measures we find there are paradigmatic Forms, Mohr says. As with the craftsman in the *Statesman*, the demiurge in the *Timaeus* 'looks at the measure of Forms, takes what is the degenerate instance of them, i.e., that which is subject to the more or the less, and makes, or at least attempts to make, a perfect instances out of it. This is what the [d]emiurge is said to do at the start of the *Timaeus* [28a,29a] and so too, *I suggest*, this is the sort of activity performed by the demiurge at [53b]' (i.e, in (1), p109).

[62] He criticises Cornford for proposing the qualities, and Vlastos, p27, p69-70 for proposing a kind of formless matter in the precosmos. See Mohr's note on Vlastos, 1985, p110, n6.

[63] The two parts (ii) and (iii) below, parallel (II) and (III) in the presentation of my model in 3.1.

[64] [Stat:283c-287b].

There are at least two problems with what Mohr says here. The first problem is connected with the fact that Mohr, as later Gerson, looks for external support for the very specific interpretation of the particular fragment of the *Timaeus*. It is always dangerous to do so, particularly given that the demiurge is not the ordinary craftsman, but the cosmic one who copies the Form of the Living Thing. As I have observed earlier,[65] there is a difference between the divine and human craftsman and their treatment of the model; while the human craftsman contemplates the model only, the divine craftsman makes a genuine copy of it. The other problem with Mohr's interpretation is that, as he says, the theory of the *Statesman* fits well the creation of the cosmos as a whole, and that he himself only *suggests* that it applies also to the becoming on the elementary level in the receptacle. I believe that this suggestion is unjustified, for there is no hint in the text of this kind of god's activity on the level of the receptacle, simply because no god's activity is mentioned at all on this level of becoming. It is not mentioned, for the god is absent from any considerations of becoming on the level of receptacle.[66]

(ii) It is evident from [53b], Mohr says, that the god works on the images of the Forms, and that images, in general, may be degenerate instances of their Forms. That this is Plato's position, Mohr thinks, is indicated by the following: First, Plato tells us that the images may not be properly called after their models (5). Second, the images are said to be in a state one would expect in the absence of the god (3), although they have some vestiges of their own nature (2), and indeed participate somewhat in measure by mere chance (4). Mohr summa-

[65] In Chapter II, section 1.2, where I have relied on the discussion in Chang, p85-9.

[66] There is only one evidently paradigmatic Form about which, we are told, the god looks at, and this is the Form of the Living Thing. It is plausible to assume, then, that the god finds in it the proportions which represent the 'fire by itself' [51b] and the proportions representing the Forms of other elements and he imposes them on the stereometric mathematical bodies floating in the precosmic receptacle. After all the first thing we learn about god's activity is that he took over things that were 'in discordant and disorderly *motion*' [30a], and not things that were twisted and imperfect.

rizes his understanding of all of these statements in the dialogue as follows: 'I take these statements to mean that the primary particles existed as recognizable, though usually degenerate, forms of what they would become when the demiurge eliminated their deficiencies and make them, each and all, completely regular'.[67]

I have given the interpretation of the same set of statements on which Mohr relies in part (II) of my argument, referring to the aggregates of the particles as objects of reference in these statements. The problem with Mohr's interpretation is that, while it is true that the particles in the receptacle are the images of the Forms of the elements, it is not the case that they need to be imperfect instantiations of their Forms and that god's action is required for their improvement. Plato does not say that the bodies in the precosmic receptacle 'had no proportionality at all' because they were images, but he says that the 'things we see' were in such a miserable state prior to god's intervention. And 'things we see' are clusters of particles, not individual particles. Only when god imposed proportions on the aggregates of the particles were they able to be seen and, in general, show their true powers. The images, then, could have been in 'imperfect state' only in one sense; they were not able to behave the way we would expect from the particles of fire or earth, although they were perfect tetrahedra or cubes; they were not imperfect in the sense that their bodies were not perfect tetrahedra or cubes.[68]

(iii) There is still one, perhaps the most controversial, statement about alleged

[67] Mohr, 1985, p109. Mohr confirms essentially his position on the content of the precosmos and god's activity in his later paper: Mohr, 1989.

[68] It seems that Mohr believes that images have to be as perfect as the Forms, for in at least two places he says something that may be interpreted this way. In one place he says: 'and so he [i.e., the god] brings them [i.e., the images] into perfect accord with their originals [51b-e]' (p111). In the other place he says that the god 'brings deviate particles into accord with their paradigmatic Forms by eliminating any degree they fall away from their paradigmatic Forms thus making them *perfect instances* of their corresponding Forms' (p108). In one of his papers on Plato's Theory of Forms, Nehamas argues that 'characters' of the Forms present in phenomenal particulars are as perfect as the Forms. He considers earlier dialogues, but he does not suggest that Plato changed his mind and required in the *Timaeus* that the god perfects the characters that enter into the receptacle.

god's activity; it is about the imposing configurations and numbers on the content of the receptacle [53b4-5]. I discussed it in my comment (III). Mohr argues against Cornford's translation of this fragment, where the Greek words *schemata*, *eidesi*, and *arithmoi*, are translated as *configurations*, *forms*, and *numbers* respectively, but evidently the problem is not in the translation, for recently Zeyl's translation is similar.[69] After analyzing the use of these three Greek words in different contexts, Mohr proposes to read this fragment rather as referring to 'alterations *with respect to* numbers' (p111), for, he says, the god never introduces numbers where they are not already.[70] He then concludes: 'In general, then, this means the demiurge thoroughly shapes the images of earth, air (etc.) which fill the receptacle, with an eye on their (excessive or deficient) characters and numbers, which they possess prior to his intervention, and so he brings them into perfect accord with their originals [51b-e]'.[71] While I agree with Mohr's argument against Cornford concerning the interpretation of this passage, I do not see how he may claim that it concerns individual particles. The reference to numbers in [56c] evidently suggests that the aggregates of particles (of the same or different kind) are affected by the imposition of proportions, and not the individual particles. It is difficult to see how the individual particles could 'accord' with respect to numbers.[72]

(iv) The 'accord' of the instantiated bodies with their 'originals' mentioned above, Mohr argues, concerns both the particles taken together as well as those taken severally [69b4-5]. Taking particles together is described, Mohr agrees, in [31b-32c] (and also in [56c] I would add). It is the imposition of proportions on

[69] Cornford: 'The god then began by giving them distinct *configurations* by means of *shapes* and *numbers*'; Zeyl in his translation of the *Timaeus* in the *Plato, Complete Works*: 'first thing the god then did was to give them their distinctive *shapes* using *forms* and *numbers*'. The relevant Greek text is: *'proton dieshematisato eidesi te kai arithmois' [53b4]*.

[70] Here Mohr looks to [56c] for support.

[71] Mohr, 1985, p111.

[72] See the discussion of proportions in Chapter II and the reference to Sayre in this discussion.

the already perfected particles. Considering particles taken severally, Mohr says, the 'numbers' referred to at [53b], involve the geometrical bodies and in particular the two types of elementary triangles which are the components of the faces of the stereometric bodies. Mohr says: 'It is this, then, from which the demiurge eliminates deficiency and which he brings into accord with their corresponding Ideas. The content of the receptacle in the precosmos, then, are primary particles which for the most part are themselves degenerate and consist for the most part of degenerate triangles'.[73]

Where Mohr errs in (iv), in my opinion, is in his insistence on the the imperfection of the individual geometrical particles in the precosmos, and even the imperfection of the subelemental triangles. This forces him to assume that the god deals with each of the instantiated particles and makes it perfect. On this interpretation, the god looks at the Form of fire and makes the individual particle a perfect instance of the image of that Form. It is evident, then, that Mohr sees god's activity on the level of elementary instantiation in the receptacle as exactly paralleling his activity on the cosmic level where he is looking at the Form of Living Thing, while constructing the cosmos. As I have already observed, there is no textual support for suggesting that there is any activity by god required on this very elementary level of becoming in the receptacle. In particular, the kind of work he is doing on the cosmic level, i.e., copying the paradigmatic model, is not even hinted at on the elementary level, for on this level no activity by god is required. The god does not, then, smooth the particle of fire in order to make it look like a perfect image of the Form of a tetrahedron.

The other problem with Mohr's interpretation is the following: Why should the images of the Forms of the elements be imperfect? After all, we are told that the receptacle is formless for this one reason only, that it does not distort the images that enter it. Perhaps, one may think, the images are distorted because

[73] Mohr, 1985, p111-2.

the receptacle agitates. Well, we are not told that agitation of the receptacle may distort images in it, and in Mohr's case it is impossible, for he treats the agitation non-literally.[74]

3.3 The content is geometrical entities: the other interpretations

In this section I will discuss some works whose main argument is not about the content of the precosmos (as is that of Mohr), but rather some other aspects of the *Timaeus*. Nevertheless, the authors in the course of their main argument have to take some position on the topic of the content of the precosmic receptacle. Morrow[75] and Strange are interested in establishing the relation of Necessity to chance in Plato's description of the precosmos, and they both assume that there are geometrical bodies in the cosmos. Gill is mainly concerned with arguing against Heraclitean flux in the *Timaeus*, and this prompts her to populate the receptacle with 'ultimate simples', the most elementary 'principles' that the god uses in his construction work. All three of these commentators assume that the world of Forms is a part of Necessity. Silverman, on the other hand, argues that the Forms belong to the domain of Intelligence. This allows him to claim that Necessity in the *Timaeus* has no separate domain and is always working in conjunction with Intelligence. In what follows I will briefly present the positions

[74] Mohr suggests one source of the imperfection of the elements in the precosmos, namely, the distortion of the elementary triangles themselves. The tetrahedron is twisted perhaps because elementary triangles are twisted. Mohr refers to places in the third part of the dialogue where triangles are weak [81c4] and warped [82d6 with e2 and 73b6]. (See also [Tim:89c1-4,81b5-c1]) He says that because the subelemental triangles may become twisted, as the above references suggest, 'we *must* assume them also to be in this state in the precosmos when the demiurge is absent' (p112). But this is a weak argument for, first of all, the triangles themselves are perhaps the images of the respective Forms, and then they do not need to be imperfect, as images of Forms in general. And second, even if the triangles are deformed while used, as references in the third part of the dialogues suggest, they did not need to be in such a condition from the beginning, i.e., from the moment of entering the receptacle for the first time. In other words, we *do not need* to assume that they were twisted in the precosmos.

[75] Morrow, 1950.

of these four commentators. I will be mainly interested in their stands about the content of the precosmic receptacle, but I will identify this stand in the context of their main arguments.

1) Morrow and Strange: Necessity and chance

Morrow and Strange argue for their interpretation of the relation of Necessity to chance, and connected with this the interpretation of chaos. They both assume that the geometrical bodies populate the precosmic receptacle. Morrow treats this chaos metaphorically for at the end of his paper he states that it is the irrational part of the world souls that is responsible for the precosmic motion (p163). Strange, on the other hand, leaves open the question of literal/metaphorical reading of the precosmos (p35).

a) Against Morrow[76]: no distinction between Necessity and chance in the text

Morrow assumes that there are 'primary bodies', fire, air, water and earth with 'inherent qualities or powers (*dunameis*)' (p152). The elements, since they are 'geometrical configurations' (p152), may interact, transforming into one another, and this explains why the elements are 'not segregated into separate regions of space' (p153). Morrow thinks that these are the materials and powers that constitute the work of Necessity (153), and that they define what in the dialogue is called 'persuasion'.[77] God's intervention, on this interpretation of persuasion, is responsible 'not for the specific effects of any given power or set of powers, but for bringing together these specific powers into such juxtapositions and collocations

[76] Morrow, 1950.

[77] He says: 'To say, then, that the cosmos comes about by persuasion means that it results from the working of the powers inherent in the materials of which it consists, each of them bringing into being the effects natural to itself, and none of them being under any constraint by a power outside nature' (p156).

that their joint natural effects are good' (p157). Having described the work of Necessity as resulting in almost orderly cosmos, Morrow has to account for all references where Plato is talking about a disorderly precosmos with the chaos coming from chance events in it, and with the god imposing the order on the chaos. Relying partly on Aristotle's interpretation of chance[78] Morrow distinguishes chaos from Necessity in the *Timaeus*. He says: 'Plato could think of both chance and [N]ecessity as characters of the world on which the creator works. Necessity is represented by the causal sequences; chance by the intersection or conjunction of these causal sequences' (p158-9). So chance differs from Necessity, for the world of Necessity follows regular causal sequences, while chance is any 'collocation of caused effects, whether relevant to an end or not' (p159). The ordering work of god amounts for joining with one another 'certain sequences' that otherwise are not 'necessarily connected'.

What is important for us in Morrow's model, as far as content of the precosmic receptacle is concerned, is to notice that the elements in the receptacle, according to Morrow, have 'geometrical configurations'. Morrow does not say in this paper whether or not these geometrical bodies are perfect or not, but he allows for the interaction between these bodies. That these bodies are images of the Forms is clear from Morrow's other paper,[79] where he acknowledges that the Theory of Forms is the 'logical foundation' (p12) of the geometrical model. In this later paper Morrow indicates that the particles may not be perfect, but it is a kind of imperfection that physical objects have in comparison with mathematical ones. Morrow says: '[I]f we consider only the relation of the subsensory particles to their paradigms the language of imitation seems as appropriate here as anywhere else in Plato. Each particle of fire, for example, is roughly tetrahedral in shape; but none of them is itself the mathematical tetrahedron, though it could well be called

[78] Although Plato gives us no analysis of chance, Morrow says, we may rely on what Aristotle says about chance in his *Physics*, for it is relatively early treatise.

[79] Morrow, 1968.

a likeness or an imitation of it'.[80] This kind of imperfection is then different from that considered by Mohr; Morrow, unlike Mohr, does not envisage any activity by god in the perfection of the images of geometrical bodies.

As far as Morrow's interpretation of precosmic chaos is concerned, as well as its relation to Necessity, it is quite obvious that it is a rather unorthodox one. Commentators generally dismiss Morrow's interpretation of the relation between Necessity and chaos as having no textual support.[81]

b) Against Strange: Necessity and chance are in the precosmos as well

As with Morrow, Strange is preoccupied with the relationship between Necessity and chance. Similarly to Morrow, Strange allows that the elements in the form of geometrical bodies are present in the precosmic receptacle. Unlike Morrow, however, who interprets Necessity as causal sequences, Strange allows only the god to be responsible for producing regularities; the regular sequences, which god produces, are phenomenal objects according to Strange. These objects have some properties defined by the constituent material, i.e., elements, but because the objects are complex, even in the work of the god, there are 'many side-effects some of which will not be good and others of which will be positively undesirable ... It is precisely these unavoidable collocations of good and bad properties that Plato would call chance' (p35).

Strange considers the structure of the world of Forms as responsible for god's difficulties in creating perfect phenomenal objects. He refers to the *Phaedo* where, as I already mentioned earlier, Socrates introduced *clever aitiai* to explain the body's acquiring some particular properties. It is, for example, fire that always brings heat to the body and never cold; and it is oneness that always brings

[80] Morrow, 1968, p25.

[81] See for example Silverman, p104.

oddness and never evenness. Similarly here in the *Timaeus*, Strange claims, some Forms entail some other and not the one which would be more suitable in the given situation. Strange's example is from the work of secondary gods [74e-75c]: the thick flesh always protects the body best, but thick flesh will not always do well for other purposes, as for example with the flexibility of the body. 'The god is then constrained by the limitations of the materials, which are due to the reflections of the Forms in the receptacle that he has organized in determinate way. So he is forced to choose between incompatible alternatives ... This constraint is Necessity which can be referred to as mutual entailments and exclusions of Forms' (p33). And Strange continues: 'Necessity, therefore, involves the Forms in the same way as *clever aitiai* of the *Phaedo* do. But Necessity is not merely formal causality: it seems to involve material causality as well' (p33). The basic material the god begins with is the images of the Forms of the elements in the receptacle. Strange considers these images as imperfect stereometric bodies, imperfect in the spirit of Mohr's model.[82] Strange is clear that the god has nothing to do with the instantiation of the Forms of the four elements. In one place he says:

'Here we are to consider the receptacle as containing only traces or *ihne* of most basic Forms (Fire, Air, Earth and Water) *before* the [d]emiurge's shaping and organizing activity begins. This indicates that Plato does not think that Reason is the cause of participation in the Forms: the [d]emiurge merely takes over these pre-existing *formal elements* and brings them to participate in better, higher Forms' (p33). And he adds that 'the Forms do in fact play an important role in Plato's conception of Necessity, not however as efficient causes'.[83]

[82]While referring to this basic content of the precosmic receptacle, Strange points twice (p28, p33) to the fragment [53c] where Timaeus talks about the 'traces' of the elements. In one of these places Strange says: 'Reason, in the person of the Demiurge intervenes at [53b] to give regular geometrical shapes to the inchoate traces (*ihne*) of the elemental bodies' (p28). These traces, then, are geometrical bodies, but as Strange says they are imperfect. He endorses the view similar to that of Mohr by saying that '[t]he passage [53b2-5] seems decisive against commentators who hold that the geometrical shapes of the elements are already present in the precosmic chaos' (p37,n14).

[83]Strange's interpretation of Necessity and chance is then different from that of Morrow, for he sees the

2) Against Gill: the receptacle is relevant for the geometrical model

Gill's main interest is the controversial passage of the *Timaeus* regarding the impermanency of phenomena which Timaeus introduces in the discussion about the 'preliminary problem about fire and the other three'[49b-50a]. My interest, however, is not in this main topic of her paper but rather in what she says about the precosmos and the alleged activity by god in her paper. Her main thesis is that in the *Timaeus* Plato does not endorse the Heraclitean model of phenomena as formulated in the *Theaetetus*, where Socrates characterizes phenomena as changing in two ways: by changing their position and by changing with respect to their character. In the *Timaeus*, Gill says, Plato allows for the changing of place but he introduces the objects which do not change with respect to their characters. These objects are the ultimate principles which Timaeus mentions while describing the structure of stereometric bodies [53d] which God uses in the construction of the physical world. Gill calls these ultimate principles the 'ultimate simples'.[84]

manifestation of both of them in the cosmos. What exists in the precosmos, according to Strange, is imperfect geometrical bodies, perhaps not interacting at all. Strange is aware of the fact that his is a rather unorthodox view for in one place he says: 'My account in terms of causal implications of Forms allows for more satisfactory account of the connection between chance and Necessity than that *explicitly suggested* by Plato' (p35, italics mine).

[84] Gill's argument proceeds as follows: In the *Timaeus* Timaeus says in the fragment mentioned above that, on account of the cycling changes between them, none of the elements can be referred to as 'this' but 'what is such' (*to toiouton*). As we soon learn, it is solely the receptacle which can be referred to as 'this', and 'what is such' is the part of the receptacle which can be fiery or watery. This is, at least, how most commentators understand the expressions 'this' and 'what is such'. Gill, however, proposes a different interpretation of the two expressions. She observes about the gold analogy in the [50a-b], that if we are not to interpret it as suggesting that 'the receptacle is a *constituent* of the things in flux, but only that it is what is permanent in the context of flux, then the receptacle cannot provide the phenomena with such permanence to license our calling them anything at all' (p47, italics mine). Why, then, Gill asks, should we here be permitted (granting that we accept the argument in *Theaetetus*) to speak of a thing in flux as 'what is such' (p47). Gill's answer is that even if there is a lack of relatively permanent structures in the precosmic receptacle we can still talk meaningfully about the phenomena, for there are some permanent entities in the precosmic receptacle. These entities, and not the receptacle, Gill says, are the *matter* of physical objects. She identifies these entities with the principles 'which the deity finds

What is important in Gill's paper for my considerations, however, is not so much her argument for a non-Heraclitean reading of the *Timaeus*, but rather her interpretation of the precosmos and the alleged activity by god on its content. As is clear from Gill's considerations, there are in the precosmos 'simples' which are images of certain Forms. These images came into existence without god's intervention, for the god deals with the ready-to-use simples. The simples, we may assume, are being instantiated spontaneously, and Forms are their causes. Gill allows for this kind of interpretation, for she says that the role of causes on this elementary level of becoming is 'differently construed' (p38) from that on the cosmic level. She points just to the fragment [51d] (as I did in section 2 of this Chapter), where Forms are called the 'father' of becoming. Gill says that '[the role of deity] as generator has been taken by the Forms', and what is in the precosmos 'deity takes in hand and organizes by means of shapes and numbers' (p39). The Forms, according to Gill, play the role of formal causes.[85]

Arguing for her particular vision of the precosmos, with the receptacle populated with the 'ultimate simples' and the god using them in the construction of stereometric bodies, Gill considers part (B), i.e., the one I have identified as de-

already as present in the receptacle and uses in constructing the bodies of the four elements' (p47). At [53d] the two right triangles are mentioned as 'originating principle' of the elements, but more ultimate principles are envisaged, principles which only the god and those dear to him know. Gill calls these more ultimate principles 'simples'. She argues that these simples, although they move in the precosmic receptacle, they do not 'alter in respect to their own character. They are eternal: a simple is *altogether and always* such as the Form which is its cause. A simple - whatever it turns out to be - will be called by its name as *to toiouton*. It is like the Form because it shares the same nature but is distinct from it because it constantly moves around through space' (p51, italics are author's). The existence of these ultimate simples in the precosmic receptacle allows Gill to claim that *Timaeus* is free from Heraclitean flux, for simples provide physical world 'the needed permanence' (p51). So, on this interpretation the Form is 'this' and its image in the receptacle is 'what is such'. There is a problem, however, with this interpretation of 'this' and 'what is such', for in the *Timaeus* 'this' is evidently a reference to the receptacle, rather than to the Form, as for example, Gerson, p51,n17 points out.

[85] She says about the Forms and their images: 'My image in the mirror is dependent upon me ... So I am the cause of the image because I determine the image as the image it is. A Form is similarly the cause of its image. This *formal causation*, as witnessed with mirrors does not require a craftsman' (p49, italics mine).

veloping the Theory of Forms on the level of the receptacle and by this applicable to the precosmos as well as to the cosmos, as referring soleley to the precosmos. Unlike, however, some other commentators who consider part (B) in complete isolation from the rest of the dialogue, Gill sees the connection of (B) with the rest of the dialogue; and she sees this connection not only with the first part of the dialogue, but also with part (D), i.e., with the geometrical model. All this, surprisingly, does not prevent her from stating that the receptacle is 'not relevant to the construction of physical bodies' (p48).[86] It is not clear at all what Gill really means in this quotation by 'not relevant', for the receptacle is evidently relevant for the construction of the geometrical bodies, even if, as on Gill's interpretation, the god constructs them. Perhaps, rather, she means that it is not required in order to describe the physical world, as it is done in (D), to make explicit reference to the receptacle, for we were already instructed how the images of the Forms of the elements are related to the receptacle. But if this is the case, we have to interpret (B) as referring not only to precosmos, but to the cosmos as well; and this is not Gill's position.

To sum up, Gill allows for spontaneous instantiation of images of 'ultimate simples' in the receptacle, and she considers these simples as the sole permanent content of the receptacle. More complicated entities, among them the geometrical bodies of the elements, can occasionally be formed by chance, as she says, referring to [69b] where Timaeus allows for such chance events, but mainly it is the god who constructs these more complex entities using these simples as primordial material. In one respect, then, namely this spontaneous (i.e., without god's intervention) instantiation of the images of the Forms, Gill's model is in spirit close to mine. I propose that the images of the stereometric bodies themselves

[86] Gill says: 'Nor is the receptacle totally forgotten in the later pages [i.e., in (D)]. Plato again mentions it at [57c3] in the context of explaining the motion of earth, air, fire, and water to different regions. And this latter mention is significant. The role of the receptacle has not been usurped by other materials. It is rather that its role is not relevant to the construction of physical bodies' (p48).

are instantiated in the receptacle spontaneously without any intervention of the god, while the god imposes on these ready-to-use geometrical bodies proportions which cluster them and make them capable of interacting. A problem with Gill's interpretation of the precosmic receptacle is that Plato never mentions any Forms of objects more simple than the Forms of the elements; not even the Forms of the two right triangles, and surely not the Forms of 'ultimate simples'.

3) Against Silverman: the Forms are also the part of the separate realm of Necessity and the qualities have functional origin

Silverman's main purpose is to show that physical objects, or particulars, in the *Timaeus* are 'constructs'; they are constructs of the images of the two kinds of Forms, traditional and geometrical. His main assumption is that Forms are in the domain of Intelligence, so he is against all interpretations of the precosmos as containing any specific material; geometrical bodies or 'ultimate simples'. He criticizes explicitly models of the precosmos formulated by Mohr, Morrow and Strange, as well as Gill, discussed above, for in all of them the Forms, in one way or another, inform the 'precosmic matter' before the god uses it. On his interpretation of the Timaeus' account of the physical world, Necessity as such has no independent domain, for Silverman says that 'no doctrine in the *Timaeus* ... requires the postulation of primitive matter' and there is 'no way to explain how motion could arise in the primordial chaos' (p103). Necessity and Intelligence are 'distinct kinds of causes' , Silverman acknowledges, but not independent of one another, and Necessity can be used in explanation only with the help of Intelligence. He says: 'How we are to understand the relation between them is dependent upon Plato's account of matter. And that account is to be found in his notion that the Theory of Geometrized space is a complement of the Theory of Forms' (p103). Silverman refers to these two Theories as the geometrical and

formal account of becoming, respectively.[87] The god causes the instantiation of geometrical forms preparing in this way space, or place for the instantiation of traditional Forms (p109-10).[88]

The problem is, however, how the Forms of properties of fire will be instantiated in just the proper place, i.e., where the tetrahedron is instantiated. Silverman seems to have no definite answer for this, for he says: 'Admittedly there is an air of *ad hoc* of this coincidence of form copy and appropriate body. Some of this air cannot be dispelled; *it does just happen* that the form-copies are matched up with the appropriate bodies. On the other hand, it is not mere coincidence ... For the blueprint for the physical construction is the very same Form, Fire Itself, that *generates* the form-copies which occur in the place defined by the triangles' (p110, italics mine). On this interpretation, then, the god prepares the receptacle for traditional Forms of the qualities to be instantiated in a particular region. But what is god's role in the instantiation of the images of traditional Forms? Silverman says: 'The traditional Forms *guide* the construction of molecular bodies in that they present to the demiurge the set of properties that anything that is to be a fire molecule must have' (p110, italics mine).

It seems, then, that it is the Form of Fire which decides that the particular properties are instantiated in the place shaped by tetrahedron. So the Form of Fire, 'Fire Itself' (p110) is a paradigm for the god. This 'Fire Itself' indicates to the god what kind of properties perceptual fire will have, so he prepares a proper place for it by instantiating the image of the tetrahedron. On Silverman's

[87] Both accounts involve, however, Forms, although these Forms are of different kinds. The geometrical account involves the Geometric Forms such as Triangle, Plane Figure, Pyramid, for example, while the formal account involves the Forms such as Fire, Justice, Man (p104), as well as 'The Hot, or The Yellow' (p110).

[88] For example the faces of the stereometric bodies are 'envisaged as form-copies or images of geometrical Forms, parallel to the form-copies or property instances of the traditional Forms' (p109). And further Silverman elaborates on this topic: 'Thus a molecule of fire will consist of both a cluster of form-copies of Fire (and form-copies of other Forms, e.g. The Hot, or the Yellow) and an arrangement of [equilateral] triangles. *The space occupied by the body of the fire molecule will be the very place in which the form-copies of Fire occur*' p110, italics are author's.

interpretation, then, the god does instantiate the images of stereometric bodies although he does not instantiate images of traditional Forms, for Silverman acknowledges existence in his model of a certain kind of 'coincidence' in matching images of these two kinds of Forms, geometrical and traditional. The god, then, according to Silverman, is rather limited in his power, and this limit comes from the Forms.[89] Silverman does not allow the god to match the images of traditional Forms with the images of geometrical Forms, perhaps because he considers god's activity metaphorically; the creation of the cosmos in the *Timaeus* is mythical, he says in one place (p108). By treating the creation of the cosmos metaphorically Silverman admits no possibility of separating in time the two states of the universe, precosmic and cosmic, and in consequence of assigning the separate domain to Necessity. And it is here, I believe, that Silverman errs. In the *Timaeus* Plato clearly distinguishes the two states of the universe, and allows for images of the four geometrical bodies to be instantiated in the receptacle, even in the precosmos. God's work, on the other hand, is that of a craftsman imposing order on precosmic chaos[90] that in consequence leads to the interaction of the elements and manifestation of the 'qualities' of physical objects. No matching of the images of traditional Forms of 'qualities' with the images of geometrical Forms are, then, necessary, for the 'qualities' have functional origin and they derive from the interactions between the elements which are constituents of both the physical objects and sense organs.

[89] In one place Silverman says: 'But *that* the elemental triangles are able to combine in the appropriate way and *that* they do combine in the appropriate way, results from the demiurge's activity. Moreover, and more importantly, he constructs them and everything else in the way that he does because the properties of the four elements and of all subsequent constructions from the elements is predetermined. What he is building is Fire, and what Fire is, the properties that Fire must have, is determined by the nature of the Form, Fire Itself' (p109).

[90] And not gluing the triangles into the stereometric bodies, I would say.

3.4 The content is 'qualities'

In opposition to those who allow for geometrical objects to populate the receptacle, the other group of commentators treats the content of the precosmos as consisting solely of 'qualities', and considers the imposition of geometrical Forms by the god on these qualities as the mark of the beginning of the cosmos. These qualities may or may not be the characters of some traditional Forms, where by 'traditional', I understand the Forms of qualities as introduced in the *Phaedo*. Cornford's position is that qualities in the precosmos are instantiations of the traditional Forms, like 'hot' and 'yellow', for example. Other commentators, like Gerson or Chang, do not consider the qualities as instantiations of the images of the Forms corresponding to these qualities, since for them it is solely the god who causes the instantiation of the images of the Forms in the receptacle, and these Forms are the Forms of the geometrical figures. Generally, all commentators who consider qualities of whatever kind as the content of the precosmos treat the description of the receptacle and the discussion of the Forms in (B) as referring solely to the precosmic state.

1) Against Cornford: no Forms of qualities are envisaged in the dialogue

Cornford treats the creation of the universe non-literally (p173), and consequently he takes chaos in the precosmos similarly. He talks, however, about a 'precosmic state' characterized by chaos, and considers this chaos 'in some sense, an abstraction - a picture of some part of the cosmos, as it exists at all times, with the work of Reason left out' (p203). The entire fragment [49b-53c], i.e., my parts (B) and (C), according to Cornford, refers exclusively to the precosmos. In his precosmos the receptacle is filled solely with 'qualities' and in particular with the qualities of the four elements. The quality of 'fire' is in Cornford's understand-

ing the combination of several perceptible qualities, like 'hot' or 'yellow'. All the qualities are instantiations of the characters of the corresponding Forms in the receptacle (p180,n1). Cornford is very strict about this interpretation, and he does not allow for linking references to 'fire' and other elements in (B) or (C) with the geometrical particles which are introduced only later in (D); these geometrical particles are connected with god's activity. Even the reference to the 'bodies' (*somata* in [50b]) he advises not to mix with geometrical structures (p181). Prior to the action of the god all references to the elements have to be understood as references to the aggregates of qualities; they alone are amenable to perception, for we perceive hotness and yellowness, but not pyramids, says Cornford (p190).

Cornford's interpretation of precosmos allows, then, for the instantiation of characters of traditional Forms in the receptacle without god's intervention; the god is responsible only for the instantiation of geometrical Forms. The problem with Cornford's interpretation is, as many commentators have already noticed,[91] that it has little textual support. Cornford's most controversial stand is with respect to objects entering the receptacle as stated in [52d-e]. We are told here that the receptacle receives characters (*morphai*) and it acquires properties (*pathe*) connected with them, and that it is filled with powers (*dunameis*). Cornford argues that all these different words (*morphai, pathe*, and *dunameis*) should be understood as referring to perceptible qualities of the elements (p199). That this is a rather dubious claim, both Mohr[92] and Kung[93] argue strongly for, suggesting that Timaeus' description of the imaging of the Forms in the receptacle in this particular fragment (and elsewhere) is consistent rather with the assumptions that it is the 'shapes' (*morphai*) that enter the receptacle.

There is still one more argument against Cornford's interpretation, namely that there is no indication in the entire body of the dialogue that Plato envisaged sep-

[91] See for example Kung, 1989, p315.

[92] Mohr, 1985, p119.

[93] Kung, 1989, p315.

arate Forms for the qualities. To the contrary, his description of the perceptible qualities within the geometrical model suggests strongly that he seriously treated qualities as derived from the interactions of the elements. In other words, Plato was not an epiphenomenalist, i.e., he did not consider phenomenal qualities as something existing independently, and in addition to the qualities derivable from the interaction of the elements. Imputing epiphenomenalism to Plato makes his theory of perception less coherent and his overall picture 'less elegant', as Kung says.[94]

2) Against Gerson: Plato does not switch from the description of the precosmos to the description of the cosmos when introducing the receptacle; all qualities have a functional origin

Gerson's argument about the content of the precosmos does not depend on the literal or non-literal reading of the 'precosmos' (p44), although he seems to gravitate toward the non-literal reading.[95] In his precosmos there is no participation in the Forms, for participation in the Forms is impossible without god's intervention (p44). Accordingly, it is the god who causes participation in the Forms of the four elements, and these Forms are the Forms of their geometrical structures, or, as he says, simply mathematical formulae (p56, 63). Since god's action marks the beginning of the cosmos, we may ask about the content of the precosmos. In the precosmos, according to Gerson, there were 'qualities' in the receptacle, like 'fiery' and 'watery', but these qualities were not images of the Forms, for Plato, Gerson

[94] Kung, 1989, p316. But Mohr, referring to the two fragments in the *Timaeus*, [45b-e] and [61c ff], suggests that Plato has 'epiphenomenal theory of perception' and that 'it seems likely that Plato is treating sensible qualities themselves as though they were motions' Mohr, 1985, p123, n26. In the conclusion of his article Mortley says: 'the particles are not characterized by secondary qualities, since these are epiphenomena consequent on the shape of the particles; this solution may best be arrived at through an examination of Plato's perception theory, since the interpretation of the myth is uncertain' (p17).

[95] For he postulates qualities in the precosmos, but at the same time he says that 'qualities never exist without quantities, except in thought'; Gerson, p55.

says, never postulated Forms for such qualities.[96]

The god imposes 'forms and numbers' on these qualities in the receptacle, and creates the bodies of the elements. But how do the elements acquire their specific qualities and not, for example, quite opposite ones? Gerson says that the properties of the elements have no functional origin, e.g., being 'hot' does not come from the sharpness of the edges of the tetrahedra. Rather, it was the god who purposefully connected the appropriate qualities residing in the precosmic receptacle with the particular geometrical figures.[97] Assuming that 'qualities' in the precosmic receptacle are not images of the Forms, and interpreting part (B) as referring solely to the precosmos, Gerson has to explain Timaeus's references to the images (*mimemata*) of the Forms [50c4-6] in this part. He says that, although these *mimemata* are explicitly dependent on Forms, they are certainly the ones that do not preserve the exact proportions.[98] However, the *mimemata* in (B) appear to be like bodies in the cosmos, as Gerson admits (p46), rather than as the qualities in the precosmos. It would be odd then, he says, to identify these *mimemata* with the 'traces' of the elements which Timaeus mentions later [53b].[99] In addition to this problem, Gerson sees another one with what he calls, 'double participation' in (B). It amounts to the fact that the Form of water, for example, looks here to be invoked to explain 'two very different sorts of intelligibility, that of the precosmic state and the cosmic state, the wateriness of precosmic water and the geometrical structure of cosmic water' (p46). Gerson solves this difficulty for Plato by suggesting that: 'it seems more reasonable to suppose that Plato,

[96] Since they are not 'intelligible predicates for they name that which is without limit', p53.

[97] He says: 'The phenomenal qualities of the elements are owing to Necessity, that is, they are unintelligible, albeit inseparable from mathematical structures' (p64). This kind of account of precosmic qualities is, however, different, Gerson says, from the account of 'cosmic qualities' like density [59b], hardness [62b-c], or heaviness [63b ff]; 'these [qualities] of course admit of mathematical characterization according to Plato' (p64, n33).

[98] For support for his claim Gerson turns to the *Sophist* [Soph:235d6-236c7] where Plato allows for two kinds of *mimesis*: images or likenesses (*eikastike*) and semblances (*fantastike*); the former preserves the exact proportions, while the latter does not (p45).

[99] And which are just qualities according to Gerson.

during the course of his description of the receptacle and its precosmic contents [i.e., in (B)], from time to time switches to the description of cosmic results of the imposition of order by the god on the receptacle' (p46).

I see two problems with Gerson's interpretation of precosmos, as summarized above. First is connected with his insistence that part (B) is solely about the precosmos. This forces Gerson to propose a dubious interpretation of the *mimemata* mentioned in this part of the dialogue, as 'semblances' rather than images (i.e., without preservation of proportions), and imputing to Plato even more dubious 'switching' from describing the precosmos to describing the cosmos in (B). Both of these suggestions are unnecessary, and Plato's *mimemata* in (B) may be seen properly, as images of the geometrical bodies (with preservation of proportions), if we just allow (B) to be the general description of becoming within Plato's Theory of Forms, which is valid both in the precosmos and in the cosmos.[100]

The other problem is with postulating the existence of two kinds of qualities, precosmic like 'wateriness' or 'fieriness', and cosmic qualities like weight, hardness and others. In part (D) Plato gives unified and very detailed description of all kinds of qualities together with sensations, all in terms of his geometrical model.[101] This model has two components: the geometrical structure coming from Necessity and the 'force', allowing for the interaction between the elements, that comes from the god. The interaction between the elements depends on both the structure[102] and on the clustering of the particles by this 'force'. Within this model phenomenal qualities are described as a result of the interaction between physical objects

[100] I call Gerson's suggestion that the qualities in the precosmos are only semblances 'dubious', for it always looks suspicious to invoke an external source (the *Sophist* in this case) to support a thesis that has no support within the text itself. The distinction between the two kinds of images in the *Sophist* is done in quite a different context, and it is not even clear that it may be applied to the microcosmic considerations in the *Timaeus*. In addition, one dubious assumption leads Gerson to another one. He suggests that Plato was switching in (B) between the description of the two different states of the universe. Why not assume that he was developing one model only, namely the model of becoming within his theory of Forms?

[101] With qualities like hot/cold included.

[102] The sharpness of the edges of the particles of fire, for example.

and organ of perception. In the last instance, then, it is the god who decides whether or not to connect structures and qualities through the proportions he introduced into the mathematical world. We may say, then, that the qualities really have their origin in god's activity, as Gerson wants, but they came from the imposition of proportions which made the interaction of stereometric bodies possible, rather than from assigning particular precosmic qualities to particular geometrical shapes; no precosmic qualities need to be postulated in order to explain the qualities in the cosmos. Contrary to what Gerson says, then, it is not that only certain 'cosmic' qualities (p64, n33), but all qualities have geometrical origin.

4. The Straying Cause: Mechanical Motion in the Universe

At the very beginning of the central part of the dialogue Timaeus says that this world came to be by the cooperation of Necessity and Intellect and this cooperation really amounted to persuasion of Necessity by Intellect that it direct 'most of the things that came to be toward what is best' [48a]. In the preceding sections of this Chapter I interpreted the nature of this 'persuasion' by looking at the content of the precosmos and at the alleged god's work on this content. In this section I will look at what Timaeus calls the 'Straying Cause'. He introduces it immediately after his comments about the persuasion, when he says that in order to understand how 'it [the universe] really came to be in this way, [he] would *also* have to introduce the character of the Straying Cause - how it is its nature to set things adrift' [48a]. I take this statement to mean that in addition to learning about the nature of persuasion we have to learn *also* about the nature of this Straying Cause, which is part of Necessity, and concerns mechanical motion.[103] Most commentators equate the Straying Cause with Necessity as a whole,[104] but

[103] The motion is mechanical in a sense that no psychic force is responsible for it.

[104] Chang, p81, is one of the few exceptions, but his interpretation of the Straying Cause differs from mine.

I think that Plato understands this cause as responsible solely for the mechanical motion in the universe. This motion is introduced, and its mechanism described, in fragment [52d-53a] or (C), the one which commentators commonly accept as referring to the precosmic state alone. Although introduced in the description of the precosmos, this mechanical motion is present in the cosmic state as well, for the two components of this motion, as I identify them, i.e., the chaotic agitation of the receptacle and the drifting motion of the elements are explicitly mentioned in the discussion of the geometrical model, i.e., in the cosmic state [57c].

4.1 Chaos in the precosmos: my interpretation

Timaeus starts the fragment in which he introduces chaotic motion with a kind of summary of becoming in the receptacle: when the characters (*morphai*) of the four elements enter the receptacle it acquires all the properties (*pathe*) which come with them and 'takes on a variety of visible aspects' [52e]. And then he says, 'but because it is filled with powers (*dunameis*) that are neither similar nor evenly balanced, no part of it is in balance. It sways irregularly in every direction as it is shaken by *those* things, and being set in motion it in turn shakes them. And as they are moved, they drift continually, some in one direction, and others in others, separating from one another' [52e]. The Straying Cause which 'sets things adrift' [48a], I believe, is evidently introduced in this fragment, but the cryptic description of the mechanism of agitation and the drifting motion of the elements makes the interpretation of these two components of the Straying Cause difficult. In what follows I propose the mechanism of agitation of the receptacle and the mechanism of the drifting motion of the elements.

1) The cause of receptacle's agitation

Timaeus compares the agitating receptacle to the winnowed basket in which the elements 'are winnowed out, as it were, like grain that is sifted by winnowing sieves' [52e]. We know, then, how the elements are put in random motion, but we still do not know who or what moves this basket. In the fragment quoted above Timaeus says that the receptacle receives the characters (*morphai*) of the elements, and consequently acquires the properties (*pathe*) connected with these characters. And then he mentions the 'unequal powers (*dunameis*)' which fill the receptacle and make it 'unbalanced': 'it sways irregularly as it is shaken by *those things* and in turn it shakes them' and as a result they are moved into separate regions. The expression *those things* refers to 'powers', but it is evident from the context that it is the elements that are moved to separate regions.[105]

But what are these powers in the first place? In the broadest sense 'powers' refer to the possibility of acting and being acted on.[106] But if 'powers' are to be understood this way, we cannot see them as objects, but rather we should look for objects between which the interaction takes place. The objects that may be identified in the passage under discussion are characters *(morphai)* and the receptacle itself, so the interaction can be between the characters themselves or between the characters and the receptacle. We may exclude, I believe, the first possibility, and accept the second one, for Timaeus clearly says that the receptacle is shaken 'by those things' and it, in turn, shakes them.

The question is how we should understand 'shaking' of the receptacle by 'char-

[105] One way out of this 'identification' problem, as proposed by Cornford, is to consider not only *morphai* and *pathe* but also *dunameis* as qualities. Cornford, p199, says: 'the qualities are also described as powers (*dunameis*), with reference to their power of acting on one another - the hot on the cold, the dry on the moist, and so on - and on the senses of an observer.' Such an interpretation of 'powers' makes certainly the reading of the fragment unproblematic: the qualities enter the receptacle, so it acquires qualities and then it is filled with qualities. These qualities shake the receptacle and the receptacle shakes these qualities in turn. Cornford's interpretation, however, has no textual support, as some commentators already observed. See for example Mohr, 1985, p119; or Kung, 1989, p315.

[106] It is as Cornford, p234-8, and after him also Mohr, 1985, p120, interpret 'powers' in the present context, and I accept this interpretation.

acters' if 'powers' are to refer to the interaction between the two. I do not see any 'force' that could be responsible for the interaction between already formed stereometric bodies and the receptacle, but I see the mechanism that could well fit the scenario of the characters and the receptacle acting on each other; this mechanism may be identified at the moment of spontaneous creation of the stereometric body in the receptacle.[107] The receptacle is filled with plane figures, elemental and subelemental triangles,[108] and also with some 'powers' responsible for their interaction.[109] Whatever this interaction is, it will normally lead to the rearrangements of these triangles without any effect on the receptacle.[110] However, the rearrangement of these triangles into the stereometric body, i.e., the formation of the image of the Form of such a body, may affect the receptacle as well, and this will result in both, the stereometric body and the receptacle moving in the opposite directions; they both will be recoiled.[111] It is, I believe, in this very act of formation of the stereometric body that we may talk about the 'interaction' between the character and the receptacle.[112]

The elementary motions imparted into the receptacle at the moment of the

[107] Having in mind the gold analogy at [50b-c] we may imagine the 'interaction' between the substrate (gold) and the image (triangle) at the very moment of creation of this image by the craftsman; the substrat 'resists' the action of the craftsman.

[108] And perhaps some other more elementary mathematical objects like 'ultimate simples' suggested by Gill.

[109] It is not clear what these 'powers' responsible for the interaction between the mathematical entities may be, but Timaus talks in [81c-e] about interacting triangles, and this interaction may even involve a 'cutting up' of triangles by one another. For example, the 'food-triangles' entering the body may be cut up by the body-triangles into ones conforming with them [81d]. The reference to interactions between the triangles is in the third part of the dialogue where the construction and functioning of human body is the concern, but I do not think that the triangles referred to in this context interect differently from those in the precosmic receptacle.

[110] It is plausible to assume, I believe, that the rearrangements of plane figures into other plane figures will not influence the three-dimensional receptacle.

[111] A physical analogue is the conservation of the total momentum in the closed system. The closed system in this case is the receptacle and the elemental triangles forming the stereometric body.

[112] The mechanism just described requires no new 'powers' to be introduced in order to account for the 'interaction' between the receceptacle and the characters. The 'powers' already existing in the receptacle, i.e., those responsible for the 'interaction' between the triangles are sufficient, except that we need some 'fluctuation' of these powers in order to form sterometric bodies from plane figures. These fluctuations may be seen as triggered by the Forms of the stereometric bodies.

creation of the images of stereometric bodies will be local and random and will contribute overall to what Timaeus calls agitation of the receptacle. The particular elementary motion imparted into the receptacle may then be considered as an integral part of the process of instantiation of the particular stereometric body, and by this it will also be temporary only, for the motion will last in the receptacle only as long as the character stays in it. When the stereometric body decays, or is disintegrated in the interaction with other bodies, the elementary motion will be taken away by the constituent triangles. The mechanism of agitation of the receptacle which I am proposing here avoids the difficulty of interpreting this motion as a permanent mark left by characters on the receptacle; Timaeus was clear in his description of the receptacle that no character may leave any permanent mark on the receptacle [50c]. In my interpretation no instantiation of the stereometric body leaves a permanent mark on the receptacle, for the motion imparted into the receptacle at the moment of instantiation of the image is taken away, in an equal amount, by the constituent triangles at the moment of disintergation of the stereometric body.[113]

2) The mechanism of drifting of the elements

[113] Like Gerson, p54, n21, but unlike Mohr, 1985, p123, I do not think that the motion of the receptacle has to be considered as the result of the instantiation of the Form of motion. Plato mentions the possibility of the Form of motion in the [Rep:529d] and introduces it explicitly in the [Soph:254b-d], but those are different developments. But Gerson's explanation of the agitation of the receptacle is different from mine. He says: 'Further, this receptacle must be in motion [30a4-5,53a3]. Motion is assigned to the world prior to the imposition of forms and numbers [by the god] for the same general reason that the phenomenal qualities are. Motion is neither part of the nature of the Forms nor can it be the deliverance of a rational god' (p54). See my earlier discussion of Gerson's position on the 'qualities' as the content of the receptacle in section 3.4 of this Chapter. Mohr, 1985, on the other hand, notices that 'Plato seems to have believed that there are Ideas of motion' (p123), and he gives references to the *Republic* and the *Sophist* quoted above to support his claim. Since the motion of the receptacle, Mohr thinks, would be the image of the Form of motion, and this imaging of the Form evidently would leave a permanent mark on the receptacle, i.e., its agitation, the assumption that the motion of the receptacle is real would be in contradiction with what Timaeus says about the relation between the images of the Forms in the receptacle, and the receptacle itself.

The drifting motion of the elements to separate regions looks as though it is proceding according to the 'like-to-like' principle. This principle was universally accepted by ancient Greeks, and it was 'unanalyzed (here as elsewhere) and assumed as obvious'.[114] But the drifting motion does not need to be interpreted in this way, for it can be analyzed in terms of two causes: first is the cause initiating the movement of the elements and the second one is the cause of sustaining it. In section 1) above I have shown how the motion of the elements may be initiated. But this initial motion will not 'direct' the elements into separate regions. Evidently it is the weight of the objects in conjunction with the agitation of the receptacle that allows elements to move to separate regions. That the weight of the elements plays a role in the motion of the elements Timaeus tells us explicitly. He says that the elements drift to their regions and they 'settle down' according to their weight: 'the dense and heavy ones in one direction, and the rare and light to another place' [53a]. This motion to separate regions, Timaeus says, 'explains how these different kinds came to occupy different regions of space, *even* before the universe was set in order and constituted from them at its coming to be' [53a]. The elements, then, had their weight already in the precosmos, and this confirms my claim, and that of those who accept the stereometric bodies in the receptacle, that the geometrical bodies were already present in the precosmic receptacle, for Plato links weight of the elements with the geometrical structure of the elements [56b].[115]

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[114] Cornford, p202.

[115] In the description of the agitation of the receptacle we find here in the precosmos [52e], the link between the agitation of the receptacle and the drifting motion of the elements is not stated clearly, for Timaeus says only that the elements 'settle down' according to their weight. When Timaeus refers to the receptacle's agitation in the cosmic state he made it a proximate cause of the separation of the elements: 'for as a result of the receptacle's agitation, the masses of each of the kinds are separated from one another, with each occupying its own region' [57c]. The fact that here the separation is seen as a *result* of receptacle's agitation suggests that the elements would not move to their places in a static receptacle. A possible reason for 'freezing' of the content of the receptacle may be the 'friction' between the elements and the finity of the cosmos. The heavier particles would

The comparison of the receptacle to the sieve and the reference to weight of the elements gives us a hint about how the elements might have separated to their regions in the precosmos. In the precosmic receptacle the particles are essentially free to move, and they are not clustered and do not interact. When shaken by the receptacle, they all 'fall down' as grain from the sieve; the heavier particles settle closer to the centre, and the lighter particles settle further from the centre of the universe. However, because the heavier particles may be formed (spontaneously) in the region occupied already by the lighter ones, they will 'fall down' to their region, eventually 'pushing up' lighter particles that might have occupied this lower region already, for there may be not enough space in the region close to the centre.[116] Since the particles are separated according to their weight, one may call the 'force' responsible for this separation the 'gravitational force'. Eventually, the 'pushing up' of lighter elements by the heavier ones, 'wanting' to occupy the position closer to the centre, may be called by the name 'buoyancy force'. All in all, the mechanism just described may lead to the almost total separation of the kinds.[117] It should be noticed here that this motion is initiated at the moment of the instantiation of the body of the element in the receptacle and sustained by the weight of this body and the receptacle's agitation. The simple mechanism of separation described above can be disturbed by chance formation of clusters of the particles, for now the clusters may be able to interact with particles in the same way as do clusters in the cosmic state. In the cosmic state, where particles

not fall down to the centre of the universe and push the lighter particles up due to the friction between the particles. The agitation of the receptacle perhaps, eases this friction and allows the particles to move according to their weight. That it is the weight of the elements *in conjunction* with the agitation of the receptacle that are responsible for the movement of the elements into 'their regions' is than now obvious.

[116] That in the precosmic receptacle the particles of different kinds may come spontaneously into existence in regions occupied by particles of another kind is plausible to assume, for Plato allows for the cosmic scenerio in which particles of the given kind spontaneously decay and subsequently recombine into the particles of a different kind [57c].

[117] I say 'almost total' for there will be always heavy particles formed far from the centre of the universe and light particles formed near the centre and they will move to their regions accordingly.

are mostly aggregated into substances, the individual particles or their clusters may be prevented from going to their regions, for they will be 'engaged in battle' [57b] with the cluster of particles of the prevailing kind. All depends now on the interaction between the elements.[118]

3) Preservation of the mechanical motion in the cosmos

The two components of the mechanical motion identified in the precosmos, i.e., the agitation of the receptacle and the drifting motion of the elements, are present in the cosmos as well. Timaeus refers to both of them when he identifies the agitation of the receptacle as a cause of the separation of the elements into their own regions. '[For] as a result of the receptacle's agitation the masses of each of the kinds are separated from one another', Timaeus says, and continues, saying that when the elements are formed not within their regions, they 'are carried by the shaking towards the region occupied by whatever masses they are becoming like to' [57c].

The question certainly may be asked whether the agitation in the cosmic state has the same cause as in the precosmos, or whether it is simply a remnant of the precosmic state. The text is mute on this subject, but I think that the first alternative is more plausible, for evidently the cause of the agitation of the receptacle, i.e., the instantiation of the geometrical bodies, is present in the cosmos as well. The proportions which the god imposes on precosmic material, as I will argue later, do not affect the process of recombination of the triangles into stereometric bodies, i.e., the process of instantiation of the images of the Forms in the receptacle, for they are responsible solely for the interaction between the clusters of elements leading to the dissociation of the bodies.

[118] See the discussion in section 2 of Chapter IV.

4.2 Chaos in the precosmos: some other interpretations

I divide those commenting on the receptacle's agitation and the character of precosmic chaos into two groups: in the first group are those who treat the agitation and chaos literally, and in the second one are those who treat them metaphorically. There is certainly much controversy about these mechanical motions connected with the agitation of the receptacle and the drifting of the elements to separate regions. This controversy arises especially in confrontation with what Plato says about the *arche* of motion in other dialogues. He claims in the *Phaedrus*,[119] and in the *Laws*[120] that soul is the sole source of all motion, but here in the *Timaeus* he seems to suggest that some motions may be free from any psychic influence, after all. I will not go into the details of this controversy about the possibility or impossibility of reconciliation of Plato's position on motion in the three dialogues just mentioned, for the problem is old and well documented.[121] Stating the controversy in most general terms, we may say that the commentators who do not make any kind of soul responsible for the chaos,[122] have to accept that Plato allows for motion which is not caused by soul. To avoid contradiction between what Plato says about the soul as the *arche* of motion in the *Phaedrus* and in the *Laws*, on the one hand, and his position in the *Timaeus* on the other hand, these commentators assume that in these two dialogues Plato talks about the cosmic state, while in the *Timaeus* the mechanical motion, without any intervention of soul, concerns solely the precosmic state.

As far the mechanism of agitation is concerned, even commentators who treat it literally do not, in general, offer an expalnation of it in the way I have done

[119] [Phdr:245]

[120] [Laws:895-8]

[121] Recently by Mohr, 1985, ch.6. He has divided the positions of commentators on this issue into five groups, and criticizes in detail the positions taken specifically by Cornford and Cherniss. Both of these commentators treat the agitation of the receptacle metaphorically, as does Mohr.

[122] Irrational soul that is different from the world soul, or the irrational part of the world soul.

in section 4.1. In what follows I will, then, survey only briefly their positions. Concerning the commentators who treat the agitation and chaos metaphorically, I will discuss and criticize Mohr's position, for it is the only one proposed recently which is presented in detail.[123]

1) Literal reading of the agitation of the receptacle

There is a group of commentators who accept as real the agitation of the receptacle and then also chaos in the precosmos. Robinson is one of them, for he advocates a literal interpretation of the chaos in the *Timaeus*.[124] But although he treats the agitation of the receptacle as real, he does not look for a specific mechanism behind its origin. He says: 'In another attempt to describe the [r]eceptacle Plato calls it [s]pace [and] [s]pace is said to be in a permanent state of motion, moving the 'forces' (*dunameis*) within itself, and itself being *swayed and unevenly shaken* by them as well' (p94). Robinson also thinks that no geometrical bodies are present in the precosmic receptacle, for he says that the use of the word 'forces' *(dunameis)* 'looks like another attempt to avoid giving the impression of any sort of material objects inside a container, or even of material particles'.[125]

The agitation of the receptacle is real also for Crombie[126]. As with Robinson, Crombie thinks that instead of looking for some psychic force behind chaos in the precosmos 'it is better to say that here Plato attributes some motion to matter in its own right, and in so doing contradicts his own principle that matter is inert and only spirit active' (p227). For Crombie 'matter' is space itself, for he thinks,

[123] I have presented briefly the interpretations of chaos offered by Morrow and Strange, while discussing in section 3.3 of this Chapter their positions on the content of the receptacle.

[124] Robinson, 1970, p93-7.

[125] Robinson, 1970, p94; he evidently follows Cornford at that point.

[126] Crombie, p227.

as I have mentioned earlier, that in the precosmos it is space that forms itself into 'rudimentary occurrences of fieriness', and in the cosmos the 'craftsman takes the hint and turns the rudimentary occurrences into genuine ones' (p219). But why would Plato think that matter can move on its own? Crombie says that in dealing with the creation of the cosmos Plato faced a dilemma; if the space is inert, the whole responsibility for the creation of the cosmos would go to the god. If matter were to play any role in this creation, it had to be active. Plato decided, Crombie says, that assigning the disorderly motion to matter was proper, for it was only a minor concession; after all, it is not motion as such that is a 'marvel' but rather orderly motion; 'Motion in itself is simply change of place, and that is not very wonderful' (p227).[127] The other commentators accept the motion of the receptacle without explanation, making it a principle of Necessity,[128] or making it responsible for the distortion of images.[129]

2) Metaphorical reading of the agitation and chaos, or, what the 'agitation' stands for

The commentators who read the *Timaeus* non-literally certainly treat the agitation of the precosmos similarly. But some who treat the precosmos literally, may treat the agitation metaphorically. Mohr does just that, and in this section I will concentrate exclusively on his position.

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[127] And Crombie adds: 'Because Plato felt mildly that motion needs explaining he sometimes said that all motion is due to spirit. Because he only felt this mildly, he did not notice that he had contradicted this principle in the *Timaeus* by ascribing disorderly motion to matter in its own right' (p227-8).

[128] See Gerson, p54, and n21.

[129] At the end of his discussion of the fragment [49c-50a] Cherry says: 'The phenomenal world results from the reflections of the Ideas on *hora*, but since this is in motion itself [52e5] the reflections are constantly being distorted, and it is from this shaking of the reflections by the *mirror* on which they are formed that the flux of sensible world results' (p8).

Against Mohr[130]: there is no interaction between particles in the precosmos

Mohr, as with many other commentators, treats the agitation of the receptacle metaphorically, but he interprets chaos literally. He first formulates an argument against the literal reading of the receptacle's agitation by others, then criticizes some metaphorical interpretations of the receptacle's agitation by others, and finally gives his own interpretation of chaos in the precosmos. In what follows I present briefly Mohr's argument against a literal reading of receptacle's agitation and his interpretation of chaos in part (I) and (III), respectively. Then, in parts (II) and (IV) I formulate my response to Mohr's position on these two topics.

(I) First, I will discuss Mohr's argument against the literal reading of the receptacle's agitation. He considers his argument as being 'based on the characterlessness of the receptacle' (p123) and he thinks that it is better than those proposed by Cornford or Cherniss[131] for a nonliteral reading of the receptacle's agitation. The argument is based on Timaeus' claim in (B) that the receptacle is a characterless entity. Mohr treats the motion of the receptacle as an instantiation of the Form of motion and he sees in the *Timaeus* evidence that the motion as such has some influence on the kind of images which are instantiated in the receptacle. He refers in particular to the following fragments [49b-c,56c-57b,58a-c] and says that they support the conclusion that 'motion of the contents of the receptacle influence what type of images are present in it at any moment and in any place' (p123). Because of this possibility, Mohr says, the agitation of the receptacle would 'disrupt the reception of all images in it' (p123). In conclusion, then, since such 'distortion and disruption' are denied by Timaeus, Mohr says, we have to assume that the agitation of the receptacle and, in turn, its being the proximate cause of the chaotic motion of the elements in the precosmos, is mythical.

[130] Mohr, 1985, ch.6; reprinted from *Apeiron* 14(1980).

[131] Cherniss identifies the shaking with with 'the continual flux of phenomena' itself, p444-5.

(II) The following objections may be formulated against Mohr's argument described in (I): (i) First, the motion of the receptacle does not need to be the instantiation of the Form of motion which Plato mentions in the *Republic* and introduces in the *Sophist* (see n113). (ii) Second, even if the Form of motion is instantiated, it is not instantiated *in* the receptacle as are the Forms of the elements (or more precisely the Forms of the stereometric bodies). It is obvious from the discusion of the fragment introducing the receptacle [50a-51b] that *in* the receptacle are imaged the stereometric bodies of the elements; the receptacle is 'the thing that is *to receive in itself all the elemental kinds* [50e]. The instantiation of other Forms, among them the Form of motion and the proportions, as the Forms of the elements, is the work of the god, and need not be understood as instantiated *in* the receptacle; they are all simply mathematical regularities imposed on the mathematical content of the receptacle.

(iii) But even if we grant for the sake of argument that the motion of the receptacle is an instantiation of the Form of motion[132] it does not follow that the images of the elements in the receptacle are to be distorted, for Timaeus forbids only the receptacle from having its own permanent characteristics or acquiring characteristics of the images that enter it as permanent ones, for he says explicitly that the receptacle is *'modified, shaped and reshaped by the things that enter it'* [50c]. The important point is that this 'modification' of the receptacle is temporary only; it lasts in the receptacle only as long as the character is present in it.[133] Mohr says that 'motion of the content of the receptacle influences what type of the images are present in it at any time and in any place' (p123), and referring to the description of motion and interaction of the elements he concludes that the motion prevents the instantiation of some bodies and by this 'it is reasonable to hold that the shaking of the receptacle is not meant to be read

[132] In my case it would be local motion of the recoiled receptacle and stereometric body.

[133] The gold analogy should be invoked here; the gold is 'modified' by the image of the triangle only as long as the image is in it.

literally' (p123). However, evidently it is the lack of place rather than the motion that prevents the instantiation of a particular element in the given region of space.

(III) If the agitation of the receptacle is metaphorical, the question arises, what is the agitation a metaphor for? Mohr's answer is that it is the metaphor for the mechanical, influenced by no psychic force, flux of phenomena. This flux has two components: one component is the motion of (imperfect) geometrical bodies populating the receptacle and the other one is their interaction and resulting intermutations of the elements.[134] Relying on these two components of the flux, Mohr declares that the 'motions in the precosmos are purely mechanical in origin' (p118).[135]

Mohr's main assumption in his interpretation of the precosmic flux is that this flux is described not only in [52d-53a], which is a part of (C), i.e., the part describing genuine precosmos, but that the description of the motion of the primary particles at [58a-c] concerns the precosmos as well. This second fragment is nested in the description of the geometrical model, i.e., in the description of the cosmic state. Whether or not it can be used in the analysis of the precosmos is at least problematic, as I will discuss later; Mohr, however, thinks that it can be. Mohr notices that appropriating [58a-c] to the precosmos is not a common position, for most commentators consider [52d-53a] 'as itself a proof-text for the views that the phenomena by themselves without psychic intervention are in the universal flux or state of chaos'. He himself, however, 'do[es] not think that [52d-53a] by itself constitutes a proof-text for it. This view can only be gleaned by taking [52d-53a] together with the description of motion and rest at [57d-58c]' (p119).

[134] So, Mohr's metaphorical reading of agitation insist on treating the agitation not as a cause of the chaos, but as an effect. Mohr says: 'Rather, I suggest, if the shaking has to stand for anything, it is to be identified with its *effect*, namely, the sifting of the phenomena according to kinds' (p123-4).

[135] With this position on the precosmic motion Mohr places himself in the group of commentators who consider Plato's position on motion incompatible with the position expressed in the *Phaedrus* and the *Laws*, where soul is considered as a sole cause of all motions.

Why does Mohr think that [52d-53a] of itself is not enough for establishing the precosmic flux? The reason, Mohr says, is that [52d-53a] by itself does not describe the chaotic state, but rather orderly motion, for it describes only 'an inherent actualized tendency' of the elements to separate, tendency to which he gives the name 'natural buoyancy' (p119).[136] This natural buoyancy causes the drift of phenomena according to kinds, and this drifting 'is being viewed as occurring spontaneously without the direct or indirect psychic cause whether of the rational or irrational sort' (p124). The buoyancy itself has its origin in the 'different objective weight of different kind of particles' (p118), where by the objective weight Mohr understands the notion of weight introduced at [65b]. As I have already noticed earlier, Timaeus connects here the weight of the particles with the number of faces of their geometrical bodies.

The buoyancy itself would not, however, produce any chaos, for it rather causes particles to undergo solely rectilinear motions towards separate regions (p125). What is necessary for the production of chaotic motion is the interaction of the particles. The particles interact, Mohr says, in the way described at [58a-c], and they have to interact, for due to the compactness of the space (no void) they cannot move freely, as they would if the buoyancy was the only force. A dense packing of the particles does not cause suppresion of the motion due to friction, but rather enhances the probability of interaction between the particles and in the final instance their intermutations (p125). As it is described in [58a-c], the small particles are trapped in gaps between the larger particles, and this is due to the

[136]It is not very fortunate to call 'actualize tendency' of the elements to separate regions 'natural buoyancy'. Since it is the 'force' connected with the weights of the elements, it rather resembles gravitational force. The name 'buoyancy force' is used in physics to render macroscopically some microscopic phenomena, and it always 'acts' up. or from the centre, as Timaeus wants. Mohr is wrong in naming forces in yet another place. Discussing the problem of interpretation of the controversial word 'periodos' at [58a5], he accepts Cornford's position, saying: 'As Cornford points out (p243-4), if *periodos* referred to a revolution of the whole universe, there would not be a tendency for the universe to remain finite but for it to expend by centrifugal force' (p129). Certainly, the universe would not undergo expansion by 'centrifugal force', even if the 'periodos' referred to its revolution, for centrifugal force is inertial, rather than real.

finite extension of space; the smaller particles cannot escape to the outer layers, for these layers are already full of particles of a proper kind. So, in effect, only when the buoyancy is taken in conjunction with the interaction of the particles, does it lead to 'the description of universal flux or chaos at [58c]' (p119). By itself the buoyancy would lead to the complete separation of elements in the precosmos; Mohr says about this conjunction: 'The two components [of the flux] are not to be distinguished temporally as the reference from [58c] to [52e2] shows. There is no time when the phenomena just sift according to kinds and do not also undergo the process described at [58a-c]' (p124, n30).[137]

(IV) My main objection to Mohr's description of the precosmic flux of phenomena is that it is not really precosmic, but is cosmic, and by this it cannot be interpreted as the metaphor for the agitation of the receptacle. The reasons behind my position are as follows: (i) First of all, Mohr's description of the flux of phenomena requires that the particles in the precosmic receptacle interact with one another, and already this is problematic. There is no indication in the description of the precosmos, i.e., in part (C), that the particles populating the precosmic receptacle interact with one another. The only reference that allows for such an interpretation is Timaeus' saying that the receptacle 'takes on variety of visible aspects' when the characters of the elements enter it [52e]. This reference, however, cannot be taken as meaning that the elements interacted in the precosmos (whether they were perfect or imperfect stereometric bodies), for we later learn that individual particles are not visible, but only their clusters, on which

[137] He summarizes his position as follows: 'I argue that Plato advances the theory of objective weight which is based on the geometrical construction of the particles. The different objective weights of different kinds of particles give the different primary particles a natural buoyancy, an inherent actualized tendency for the particles to separate according to kinds. However as a result of the formal properties of space and the differing efficiency with which different geometrical particles can be packed in space, the natural buoyancy of primary particles indirectly causes the particles to be thrust back together again, and so the flux of the phenomena is caused and maintained by purely mechanical means' (118-9).

god imposed several proportions [56c].[138] (ii) The second point is that even if for the sake of argument we allow the particles in the precosmos to interact, we may still ask whether this interaction is of the same character as the one in the cosmos. Mohr himself acknowledges that the imperfect particles of the precosmos are perfected by the god and that god indeed imposed proportions on them (p111). Does it mean for Mohr that these perfected particles with the proportions imposed on them by the god interact in the same way as the particles in the precosmos? Mohr's answer seems to be 'yes', for he uses the description of the motion and the interaction of the elements that evidently refer to the cosmic state in his analysis of the flux in the precosmos.

Taking both the above arguments, (i) and (ii), together we have to conclude that it is illegitimate to appropriate the fragment [58a-c] and other fragments Mohr refers to, which evidently concern the motion and the interaction of particles in the cosmos, to the description of the precosmos. I am thinking here especially about the fragment [56c-57b] where the importance of the clustering of the particles in the description of the interactions between them is evident. What Mohr has really described is the phenomenal flux in the cosmos, rather than the one in the precosmos. In effect, then, the precosmic agitation has to be, after all, taken literally, and not metaphorically. Moreover, as Timaeus tells us, this precosmic agitation is present also in the cosmic state as a proximate cause of the drifting of the elements [57c]. Mohr considers this drifting motion not as drifting but rather as a rectilinear motion and he thinks that it is self-initiating and self-sustaining. He calls it 'an inherent actualized tendency for the particles to separate according to kinds' (p118). I think that this 'tendency' would remain a tendency forever, and it never would actualize if the receptacle did not agitate.

[138] As I have already observed, the other reference to the 'visibility' of the precosmic material [30a] in the first part of the dialogue also indicates that this precosmic visibility should be taken as visibility to the god, and then not necessarily involving interaction of the elements which is essential for the physical visibility as described in the cosmic state within the geometrical model.

IV. THE INTELLIGIBILITY OF THE PHYSICAL WORLD: THE GEOMETRICAL MODEL

The intelligibility of the physical world in the *Timaeus* is achieved within the geometrical model of becoming. The geometrical model, as I understand it, has two components: one is the stereometric structure of the elements, and the other is the mechanism of their interaction. The structure of the elements is mathematical and it is the work of Necessity. The interaction of the elements, on the other hand, is determined by the 'force' which is introduced by the god through the proportions imposed on these mathematical structures. The model is introduced in the central part immediately after a short discussion of the precosmos. First, we have the description of the model on the microscopic level (structure [53c-56c] and interactions [56c-58c]). Next follows the discussion of the variety of substances in the physical world [58c-61c] in terms of the model, and finally we have the description of perceptible qualities and sensations [61c-68e] exclusively in terms of the model as well. The description of changes in the physical world within the geometrical model has only one direct reference to the god and only an indirect reference to the Theory of Forms, and it may be easily perceived as purely mechanical. In order to dismiss this misleading perception Timaeus tells us in the summary of his account of the changes in the physical world at the end of the central part of the dialogue that, although the god used necessary causes (i.e., elements) as 'subservient', it was he himself who designed all that comes to be in the universe [68e]. Plato urges, then, the philosopher in these concluding remarks to look always for both kinds of causes, necessary and divine, for the latter are always being hidden behind the former [69a].

In opposition to the previous Chapter which dealt exclusively with the precosmic state, this Chapter deals exclusively with the physical world in the cosmic state. First, I will argue that the way the geometrical bodies are introduced in

[53c-56c] supports my claim formulated in the preceding Chapter, that the content of the precosmos may be seen as purely mathematical (including the perfect stereometric bodies), and that the god made this mathematical content physical by imposing proportions on the geometrical bodies. Then, I will argue that the description of the interaction between the elements, which leads to their transmutations, suggests that the clustering of elements introduced by the proportions is the force responsible for these interactions and that, in effect, this interaction is the only factor distinguishing the cosmic from the precosmic state. Finally, I will show that the unified description of substances, their properties and the mechanism of sensations suggests strongly that all qualities in the *Timaeus* have a functional origin; they are phenomenal manifestations of the interactions between the geometrical particles. There is no need, then, to treat the phenomenal qualities as something present in the receptacle, in addition to the qualities emerging within the geometrical model; in other words, it is wrong to assume that Plato was an epiphenomenalist.

1. The Principles and Causes

Since we deal with the physical world in the cosmic state, we may expect that principles and causes identified on the cosmic level in the first part of the dialogue are valid here as well although we are considering here subcosmic phenomena. Additionally we may expect to find on this level the principles and causes related to Necessity in the precosmos.

On the cosmic level it was the god who was introduced as the teleological principle and the sole cause of the genesis of the cosmos. The god was using the four elements as 'accessory causes' *(sunaitiai)*. We were told that he imposed a particular proportion on the elements in order to assure the unity and friendship in the universe [32a]. The god himself, and his specific activity of imposing proportions,

is affirmed on the subcosmic level that we are considering in this part of the dialogue [56c,68e-69b]. It is he who gives a fair design to everything that comes to be, although the material he uses, the elements, is in its nature determined by Necessity [68e]. This material and its motions are now called the 'necessary causes' which are said to be subservient to the god [68e]. Evidently, then, the 'accessory causes' from the cosmic level have been subsummed under the 'necessary causes' in this part of the dialogue.[139]

The two principles of the theory of the Forms identified in the first part of the dialogue (being and becoming) have been supplemented earlier on the very elementary level of becoming (i.e., level of genesis of the elements) by the third one, the receptacle, and we may assume that all three are operational in becoming in the physical world in the cosmic state; we are told that they 'existed even before the universe came to be' [52d], and we may assume that they exist now as well. Within the description of becoming in terms of the geometrical model we have one direct reference to the receptacle (its agitation [52e]) and a short explanation of why there is so little interest in the Forms in this part of the dialogue. This explanation emerges from casual remarks by Timaeus in the fragment where he describes the substances. Timaeus says there that within his 'likely story' he is concerned solely with 'likelihoods on these subjects' and 'take[s] a break and lay aside accounts about the things that always are', for the pleasure coming from such an inquiry will 'provide his life with a moderate and sensible diversion' [59c-d].

In addition to the principles and causes already introduced earlier on the cosmic level, and those introduced by Necessity, Timaeus explicitly introduces here the mathematical principles which are operational in becoming on the microcosmic level of the receptacle; these are the principles of plane and solid geometry. The two right triangles, one with two acute angles equal and the other one with one acute angle twice the other, are identified as the 'originating principle' of the

[139]The word *sunaitia* is not used in this part of the dialogue at all; see Brandwood, *A Word Index to Plato.*

elements, for they are components of the faces of the stereometric bodies that are assigned to the elements. The stereometric bodies, in turn, are considered as composed of their faces, i.e., as composed of plane figures. I discuss these mathematical principles more comprehensively below.

2. The Geometrical Model of Becoming

The geometrical model of becoming, as I have mentioned earlier, has two components. The one is the mathematical structure of the elements that I see as originating in Necessity, and the other one is the mechanism of interaction between the elements that has its origin in the action of the god who imposed proportions on these mathematical objects. I will first discuss the mathematical structure of the elements, and then, I will suggest that the mathematical principles introduced in this part of the dialogue may be connected with those introduced in the so called second hypothesis in the *Parmenides*. Finally, I will argue that the god changes the mathematical world of non-interacting stereometric bodies into physical elements which can interact with each other.

2.1 Microcosmos: mathematics

Timaeus introduces the geometrical structure of the elements by referring, one would say, to one observation (that the elements are bodies as 'everyone knows' [53c]), and then by relying exclusively on the mathematical principles, namely the principles of plane and solid geometry. It will be the principles of plane geometry that count in the last instance, for Plato considers the stereometric bodies as composed of their faces.[140] Every bodily form has depth, Timaeus says, and every depth is 'of necessity comprehended within surface' [53c]. Every plane surface

[140] As is obvious from his description of the intermutations of the elements, what counts in these intermutations are the faces of the bodies and not their volumes.

bounded by straight lines, he continues, is divisible into triangles of which each may be divided into two right triangles; one isosceles and the other one scalene. These two right triangles are assumed here to be the 'originating principle' of the elements [53d]. But they are 'principle' only within the 'likely story' which Timaeus is pursuing, a story that allows for Necessity to be a part of the explanation. More 'ultimate principles' exist, Timaeus says, but they are known only to the god and those dear to him [53d]. We may safely assume that at least some of these more ultimate principles are mathematical ones. The reference here to the more ultimate principles just suggests, I believe, that Timaeus is preoccupied in this fragment with the principles, and not merely with the construction of the stereometric bodies by the god; the god, after all, is mentioned here as a knower only, and not as a doer.

After identifying the two right triangles as 'the originating principle of fire and the other bodies' [53d] Timaeus asks about 'the most excellent four bodies' [53e] that would fulfill one only condition, namely that at least some of them 'are capable of breaking up and turning into other and vice-versa' [53e]. If Timaeus' goal in this inquiry into the geometrical structure of the elements were utilitarian only, i.e., if he wanted to find the stereometric figures of which some 'are capable of breaking up and turning into other', with the plane geometry figures as principles, he would finish his search for the 'principles' here and would find that the scalene right triangle, identified above as one of the two which are basic, should have one of its acute angles twice as large as the other. The reason for this is that only such a right triangle, when combined with another of the same size, is able to form an equilateral triangle, which can be used in the construction of the three stereometric figures (i.e., tetra-, octa-, and ikosahedrons), i.e., the figures that fulfil his condition of intermutability stated above ('breaking up and turning into other').

Timaeus is, however, considering mathematical principles, so he goes back to

principles of plane geometry and (without any reference to the requirements of the solid geometry, i.e., mutability of the bodies), finds, among 'infinitely many' scalene right triangles the 'most excellent' one; as it happens it is the triangle with two acute angles in a simple proportion 1:2, and this 'most excellent' triangle has the property suited precisely for the construction of the faces of stereometric bodies, i.e., it in combination with a second similar one forms the equilateral triangle. That Plato thinks seriously about principles in this whole argument about the 'most excellent' right triangle, and not primarily about application, is indicated by the fact that he challenges anyone to find an even more excellent right triangle than the one he proposes.[141]

After deciding about the 'most excellent' right triangle Timaeus switches to considerations of solid geometry. Considering the four stereometric bodies one by one, he states the number of planes that form solid angles in each of them, the number of faces in each body, and the number of the elementary right triangles forming these faces. As far as faces of the bodies are concerned, Timaeus considers six 'most excellent' right triangles, as composing each of the triangular faces of tetra-, octa-, and ikosahedrons, and four of the other type of right triangles, as composing the square faces of the cube. In both these cases, i.e., triangular faces of the first three stereometric bodies, and the square face of cube, it would be adequate to compose each of them out of two right triangles of the respective kind. The reason Plato chooses six and four right triangles, respectively, is not elaborated on in the dialogue.[142]

[141] Some commentators evidently do not read this passage about the most excellent triangle carefully, as for example Chang, p95, or Pohle, p44, for they talk about 'the most excellent *triangles*', suggesting that the right triangle with two equal acute angles is also considered to be the most excellent. Timaeus, however, evidently refers to only one triangle as the most beautiful among the 'infinitely many'. The other one is unique and no choice is necessary on the basis of its excellence. See the discussion of the most beautiful triangle in Falus.

[142] Cornford, p230-39, thinks that it has something to do with reducing the rate of growth of the size of the elementary bodies in cases when the larger grains are formed, but Pohl, I think, refutes him decisively. Perhaps the best proposition is that of Heath, p98, who suggests that Timaeus' particular choice of the number of right triangles forming the faces of the stereometric figures, has some Pythagorean connection. The strength of such a

It should be clear by now that I see the way in which the geometrical model is introduced in this part of the dialogue as a strong indication that there is no place for god's activity within the model so far. What we have in this introduction is, rather, an attempt at formulating a scientific (i.e. mathematical) theory. The language Timaeus uses is neutral, without the slightest indication of god's involvement in gluing the triangles together in order to construct the stereometric figures or restoring twisted stereometric bodies to their perfect shapes. It is rather a language of the scientist formulating a model which he is prepared to test. Timaeus says repeatedly 'we'; we posit the principles; we should decide about the most excellent bodies, and we posit the most beautiful scalene right angle triangle. The scientist formulating the model will go to the level of mathematical principles that suits him best in achieving the intelligibly he judges to be adequate.

In summary, Timaeus warned his listeners that his will be an 'unusual account' [53c], and it really is; it is unusual in at least two senses; first, the elements are proposed to be composed particles; and second, their structure is presented as a purely mathematical one. The god is not involved explicitly in any activity of constructing the stereometric bodies, contrary to what many commentators assume; the god is mentioned here solely as a knower of more fundamental principles. He will be mentioned as doer soon [56c] when we enter into the construction of the physical world; we will learn anew, as we learned earlier already, that the god is imposing proportions on the stereometric bodies.

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suggestion is enhanced by a similar Pythagorean connection found in the reference at [53d] to the 'more ultimate principles' (see the discussion on mathematical principles below). I would propose one more solution to the problem of divisibility of faces of the stereometric bodies into right triangles. The bodies with the construction of the faces as proposed by Timaeus (six, or four elementary triangles instead two) are easier to break up. The sharp solid angles of bodies may break up the bodies easily, while they strike the surface, when this surface may be broken along several lines. One more point against Cornford: if Plato's concern were about the size of the elementary bodies he would insist that the triangular faces of the bodies are composed out of eight (not only six) right triangles.

2.2 The mathematical principles in the 'Parmenides'

Timaeus introduces the right triangles as principles of plane geometry, for they may be used in a construction of any plane surface limited by straight lines. Because two of them, one isoceles and the other scalene with one acute angle being twice the size of the other, will be the components of the faces of stereometric bodies, which later will be assigned to the elements, Timaeus calls these triangles the 'originating principle' of the elements [53d]. The god and the wise man, Timaeus says, knows more ultimate principles but he, Timaeus, will not use them on the level of his 'likely story'. He already told us earlier in [48b-e] that his account of becoming in the physical world will not be on the level of principles, since 'for the present [he could not] state *the principle* or *principles* of all things' [48c]. We may wonder what this *principles* of all things referred to in [48c], or these 'yet more ultimate principles' mentioned in [53d] may be.

A proper place to look for these more ultimate principles is, I believe, the *Parmenides*. In the second part of this dialogue, in what commentators identify as the 'Second Hypothesis' [142-146], Plato shows how lines can be generated from the first principles. He has here Parmenides, who uses One and the three basic kinds, Being, Same and Different, generating numbers, and from them lines. Parmenides starts from the assumption of One, then goes to the construction of Indefinite Dyad, then to the construction of arithmetic numbers, and finally to the construction of individual units. These units are subsequently used in the construction of geometrical lines, straight or curved, or a combination of the two. Turnbull considers this scheme of generation of numbers as clear indication that the world of Forms is the world of ideal numbers, and that the generation is nothing else but the production of numbers in the receptacle. He says: 'As I read [the passages in the *Timaeus*] concerning the mathematizing activity of the demiurge, that mathematizing activity is the informing of the Receiver [i.e., the

receptacle] by what, in the *Parmenides*, are taken to be the numbers. Given the close association, if not identity, of the numbers and shapes, this informing results in the mature Plato's physical world'.[143]

Sayre also thinks that the Second Hypothesis in the *Parmenides* supplies the scheme of generating lines from the first principles. He quotes a passage from Alexander Polyhistor (of the first century B.C.) indicating the connection of this scheme of generation with the Pythagorean ontology.[144] But if the Second Hypothesis in the *Parmenides* can be interpreted as supplying the method of generating lines in the final step, then, we may see the search for the principles of plane and solid geometry in the *Timaeus* as the continuation of the development initiated in the *Parmenides* to the realms of higher dimensions, i.e., plane and stereometric figures. In this context the reference to more ultimate principles in the *Timaeus* at [53d] would be just a reference to lines and perhaps to numbers, and the 'principles of all things' referred to in [48c] would be the One and the Indefinite Dyad of the Parmenides' Second Hypothesis. I will not argue for this particular connection between the *Timaeus* and the *Parmenides*, for certainly it is beyond my capability, but it is interesting link worthy of exploration. My argument about

[143] Turnbull, p69. But Turnbull considers the demiurge to be mythical figure, so what he calls mathematization of the receptacle has to be a spontaneous process on his interpretation.

[144] Polyhistor passage quoted in Sayre, 1996, p177-8, goes like this: 'The first principle of all things is the One, which is cause. From the One and the Indefinite Two come numbers; and from numbers, points; from points, lines; from lines plain figures; from plain figures, solid figures; from solid figures sensible bodies'. The passage was written in the first century B.C., so, Sayre says, it is 'a matter of debate' whether the fragment presents Pythagorean ontology in the century before the *Parmenides* was written correctly. 'But it should be clear', he continues, 'that the *derivations* cited in this passage closely match the development of the Second Hypothesis thus far. From the One posited initially in setting down the hypothesis, Plato has moved in sequence to an Indefinite Dyad (the *apeiron plethos* of 143a2), hence to the arithmetic numbers (144a4), and onward to individual units (parts of the one as a whole) that are infinitely numerous (at 144e5, perhaps analogous in role to the Pythagorean points). The aim of the project currently underway [i.e., in 145b] is to show how these units (parts of one as a whole) might enable the construction of geometrical lines - whether straight or round (i.e., curved) or combination thereof' Sayre, 1996, p178. It may be added here that Nicole, thinks that it was Plato who introduced the notion of 'indivisible line', for he did not consider points as part of the line; rather 'indivisible line' was considered as the smallest component of the line. See also Kung, 1988, p172, n10, on this subject.

the geometrical model, fortunately, does not depend on this particular connection.

2.3 Microcosmos: physics

1) The structure of the elements

After describing in detail the structures of the four stereometric bodies Timaeus assigns each of them to the particular element. The three bodies with triangular faces, tetra-, octa-, and icosahedrons, are assigned to fire, air, and water, respectively, and cube to earth. The reason for this particular matching of the stereometric bodies and the elements is based evidently on the observed properties of the elements; the fire is most mobile, so it has to be the most light; for this reason tetrahedron is most plausible choice for the molecule of fire. Earth, on the other hand, is 'the most immobile and the most pliable', so cube is most likely as the shape of the molecule of earth; and similarly with the remaining two elements [55e-56a].

The language Timaeus uses while deciding about this matching is characteristic of somebody looking at ready-to-use objects in anticipation of using them for a specific purpose: 'Let us now assign to fire, earth, water and air the structures which just have been given their formations in our speech' [55d]. We may expect that the god looking at the stereometric bodies, and intending to fulfill the task of creating the most perfect world coded in the Form of Living Thing, decided about this particular matching. We should also note a specific use of language, the elements have been given the structures 'in our speech'; there is no indication that these structures were given to the elements by the god.

With this assignment of the stereometric figures as shapes of the moleculae of particular elements, mathematics turned into physics. As a consequence, we have the god entering the scene. We are told in this place that since the individual

geometrical bodies are very small, they have to be clustered in order to be seen, and that it is the god who causes this clustering by imposing of the proportions on the elements:

'When, however, a large number of them [the elementary bodies] are clustered together, we do see them in bulk. And in particular, as to the proportions among their numbers, their motions and their other properties (*dunameis*), we must think that the god had brought them to complete and exact perfection (to the degree that Necessity was willing to comply obediently), he arranged them together proportionately' [56c]. Essentially we have then in this fragment confirmation of god's activity described in [32a-c], except that now the characteristics that are the subject of god's attention are specified more explicitly; they are 'multitudes' (or 'numbers'), 'motions' and 'powers'. The fact that Timaeus repeats his characterization of god's activity in this particular place, and that he mentions here also Necessity, as something that the god was respecting, is important, for this indicates that the god was dealing with stereometric bodies when he started his work, which were brought about by Necessity. The fact that the elements are the product of Necessity is further confirmed in [68a], as previously noted.[145] What follows now in the dialogue is the description of mutations of the elements, and the explanation of why and how the movement in the cosmos is preserved. Both descriptions rely heavily on the notion of elements acting as aggregates of particles, rather than as individual particles.

2) The interactions: disintegration

With the imposition of proportions on the elements, resulting in their cluster-

[145] Why would god's activity be mentioned only here, when the elements were already identified as stereometric bodies, and not earlier when the problem of constructing of such bodies was an issue, if the god had any say in imposing 'forms and numbers' on individual particles rather than on their aggregates? Obviously, it is most plausible to assume that he had found in the receptacle the ready-to-use stereometric mathematical objects.

ing, it became possible for elements to interact. In the mechanism of interaction, leading to transmutations and motion of the elements, I distinguish kinematic and dynamic components. Kinematics involved in this cosmic micro-mechanics is essentially the same as that in the precosmos, i.e., the elements move toward their separate regions, as I have argued earlier[146] on account of the agitation of the receptacle and according to their weight. As far as dynamics is concerned, I distinguish its two manifestations: one is the disintegration of the elements, and the other one is their recombination. The mechanism of disintegration of the elements, as I see it, is a well rendered process, but Timaeus supplies us with only a very vague description of the process of the recombination of the particles. I believe that this asymmetry in the description of the two components of the elemental dynamics is not a mere overlooking of the importance of the recombination. Rather, it has its origin in the fact that the disintegration of the elements is due to well defined forces originating, in the final instance, in the proportions imposed by the god on the elements, while the recombination is here, as it was in the precosmos, essentially a random process.

As in the precosmos, the receptacle agitates also in the cosmos, and the elements move to separate regions. The link between the two motions, the agitation of the receptacle and drifting of the elements, is stated here even more clearly than in the precosmic state: 'for as a result of the receptacle's agitation, the masses of each of the kind are separated from one another, with each occupying its own region' [57c]. Unlike in the precosmos, however, the separation of the elements in the cosmos is not complete, and this incomplete separation may have two sources. First, there is the interaction between particles in the cosmos, and particles of one kind are engaged very likely in a 'battle' with the particles of the other kind [57b]. Second, there is virtually no empty space, such that the smaller particles will be trapped in the gaps left in the aggregates of large particles, where they are the

[146] In section 4.1 of Chapter III.

only particles that can fit in [58a]. In the precosmos, aggregates were formed by chance only, so they were entities infrequently appearing in the receptacle; in effect the interactions in the precosmos were rather rare events. Individual particles were not interacting with each other and, then, they moved relatively freely to their regions, producing in effect almost complete separation of different 'kinds'.

As far as dynamics is concerned, the two things are clear: first, that there is no interaction between the particles of the same kind [57a], and second, that the final outcome of the interaction between the particles of different kinds is determined by the powers of the aggregates of the particles, rather than by shapes of the individual particles. In other words it is physics rather than mathematics that decides about the transmutations, although shapes of the particles play the role of instruments through which the interactions take place. Generally, Timaeus considers two scenarios for the interactions between the elements: the first one is when the small amount of a lighter element is trapped within the large amount of a heavier one; and the second one is when the small amount of a heavier element is enveloped by the large amount of a lighter one. The first case concerns the example of a small amount of fire caught inside air or water; when this happens, the fire will be 'shattered and quenched' unless it is 'willing to be reconstituted into the form of the kind that prevailed over them' [57b]. If, on the other hand, the small amount of air or water is caught in the large amount of fire, the heavier particles will be cut into elemental triangles (or even subelemental ones) due to 'the sharpness of fire's angles and edges' [57a], and the process will not stop until everything is 'reconstituted as fire' [57a]. Of course, if there is not enough space for a large particle of the same kind as surroundings to fit the gaps within the aggregates of large particles of surroundings, the smaller particles will fill these gaps [58a-b]. The case of earth is certainly unique, for the faces of earth can only be recombined into the moleculae of earth, So 'when earth encounters fire and is broken up by fire's sharpness it will drift about ... until its parts meet again

somewhere, refit themselves together and become earth again' [56d].

3) The geometrical bodies: are there any powers connected with their shapes?

As it is, then, clear from this description of the interaction of the elements, what is important in it is the 'strength' of the 'prevailing element', and not so much shapes of individual geometrical bodies. These shapes are solely the 'instruments' by which the process of disintegration occurs. It is certainly true that Timaeus invokes the 'sharpness of fire's angles and edges' (and to some extent also similar properties of air [56d]) in the description of the disintegration of particles, but sharpness of edges of fire, for example, is not the 'force' responsible for this process; this force is external to the powers of individual particles.[147] At best, these internal powers connected with sharp edges and solid angles of geometrical bodies would be dormant until they are triggered by these external powers imposed on the aggregates of the bodies by the god through proportions. That geometrical shapes by themselves cannot be responsible for the interactions between the elements is further indicated by the following considerations:

(i) If the sharpness of edges and solid angles of fire and even air are accepted as responsible for 'cutting' other particles, we have to ask for particular features of heavier particles responsible for what Timaeus calls 'shattering and quenching'; there is certainly a problem with clearly identifying any.

(ii) If it is geometrical shape that is solely responsible for disintegration of particles, we may assume that such a disintegration is a purely mechanical process; the particles, while drifting, bounce off of one another and eventually shatter the faces of particles they scatter from. This kind of 'interaction', if possible, should be first of all detected in the precosmos. The text, however, gives no indication of any kind of interaction in the precosmos. In the cosmic state it is evidently the

[147] If the individual particles have at all separate powers connected with their shapes, in which I do not believe.

'strength' of aggregates that decides the outcome of the interaction between the different kinds of particles (even if it is a purely mechanical disintegration, i.e., disintegration by powers connected with the shapes of geometrical bodies would be possible).

(iii) And there is still one more argument against the assumption that it is geometrical features of the elements that are responsible for the interaction between them. If this interaction was determined solely by the shapes of the geometrical bodies, it would be purely mechanical, and we could expect that the interaction between the particles of the same kind would not be forbidden absolutely as it is, for we may still think of the particle of air disintegrating another particle of air. The solid angle of the tetrahedron should be able to break up the face of another tetrahedron as easily as it breakes the face of octa-, or ikosahedron, or cube. Only if it is god who decided about the characteristics of interaction between particles, may we expect that some interaction will be forbidden absolutely: 'a thing of any kind that is alike and uniform is incapable of affecting any change in, or being affected by, anything that is similar to it [57a]'.

4) The interaction: recombination

So far we were looking at only one manifestation of the dynamics of interaction between the elements, namely, the dissociation of the geometrical bodies. To repeat, we have identified essentially two processes responsible for this phenomenon: first one was the 'cutting' of the large particles by smaller ones, and the second one was the 'shattering' of smaller particles by the larger ones.[148] As far as the second manifestation of the dynamics is concerned, namely the recombination of the triangles into the bodies of the elements, Timaeus is far less explicit. About recombination Timaeus says only vaguely that the triangles 'refit themseves to-

[148] There is still the possibility of random dissociation of the particles [57c], but this possibility is not essential for our considerations here, and it only supports my claim that random processes are possible in the cosmos.

gether' [56d], or that the 'parts recombine' [56d]. But why the triangles recombine at all, and why they recombine to particular bodies is never stated explicitly. Explicitly stated are the 'laws of engagement': two different pure kinds will always be engaged in the 'battle' [57b], and the battle will not stop unless the particle is 'willing to be reconstituted' into the form of the prevailing kind, or it is possible for it to escape the trap [57b]. But why the particle is not immediately 'willing' to assimilate to the prevailing kind is not said. That the elemental triangles can recombine to any of the three lighter bodies (but not to earth) even in the presence of a prevailing quantity of one of the other kinds is an indication, I believe, that the process of formation of individual particles from the triangles is essentially a random process, and it does not depend on the environment. No powers originating in the proportions imposed on the elements by the god and responsible for clustering and, in effect, on the interaction of the elements are involved in the process of recombination of the triangles into the stereometric bodies. Powers responsible for the recombinations are those connected with the triangles themselves, or they are present in the receptacle in another way. Timaeus' cryptic references to recombination of the triangles into the bodies is another indication (as was his acknowledgment that the instantiation of the images in the receptacle is difficult to explain; [50c,51b]) that there is no involvement by god in this process; the god imposed powers on the stereometric particles and they are such that in general they enable the interaction of the clusters of such particles. Among other characteristics of these powers one of the most important is this: on one hand, the different kinds of particles always interact, and on the other hand, the interaction between the particles of the same kind is absolutely forbidden.

3. The Terrestrial Mechanics: A Unified Description of Substances, Properties and Sensations

The geometrical model of the elements is tested, we may say, in its application to the description of changes in the physical world on the terrestrial level. The successful unified description of the varieties of substances, their properties and also the mechanism of sensations, is a demonstration that the model is plausible. The unified description of perceptible properties and sensations proves that the postulate of the existence of 'qualities' different and independent from those emerging from the geometrical model is unnecessary.

3.1 Varieties of substances

The first terrestrial problem Plato tackles relying on the microscopic geometrical model just developed, is the problem of varieties of macroscopic substances. We have already learnt two things about these substances. The first is that the substances as objects of perception are really conglomerates of a large number of elementary particles of the four elements, for the individual particles are too small to be seen [56c]. The second is that the variety of substances of a given kind has its origin in different sizes of particles of the elements, which in turn has its origin in different sizes of subelemental right triangles [56c-d]. Whether or not these elementary right triangles are commensurable is not clear.[149]

Substances encountered on the terrestrial level may be conglomerates of one kind of particles (in which particles may or may not be of the same size), or they

[149] Commentators like Cornford, and after him O'Brien, opt for the commensurability, although there is no firm textual support for this position; see O'Brien, p84, for details. One argument, which I think, gives additional support for such an interpretation, is that Timaeus suggests maximum proportionality [69b] not only between the different kinds, but also proportionality within the one particular kind, and commensurability of the subelemental triangles of different size would deliver such a maximum proportionality.

may be mixtures, i.e., the conglomerates of particles of two or more different kinds. Substances may be in different physical states: gaseous (fire and air), liquid, or solid, and the state of the substance may change when it is under influence from the environment. The state of the substance depends on the elements of which it is composed, and on the presence or absence of even small admixtures of particles of another kind. The shapes of the geometrical bodies of particles and the kind of interaction in which they may be involved matter in all changes of physical states of substances.

1) Substances

Concerning particular substances, it seems that fire and air may form pure substances, i.e., without admixtures of other elements [58c-d]. Water and earth, on the other hand, come mostly in mixtures with each other, and with fire or air, although they can also form pure substances. The physical state of the particular substance depends on the fineness of particles of a given kind, if it is a pure substance, or on the prevailing kind in a mixture. For example, water as a pure substance may come in two varieties: as liquid, or as a liquefiable substance. The main characteristic of liquid is that it 'possesses water parts that are not only unequal but also small' [58d], and therefore they are 'mobile, both in itself and when acted upon by something else' [58d]. Liquifiable substances, on the other hand, are 'composed of large and uniform kinds' and, as a result, they are 'rather immobile and heavy, compacted as it is by its uniformity' [58e]. Examples of substances of this second kind are some metals like gold and copper. These metals are composed solely of the water particles, and the difference between them Plato explains by their internal structure; there are larger gaps between the particles in copper that results in a smaller density of copper in comparison with gold [59b-c].

Many varieties of water are really mixtures of water particles of different sizes; these mixtures are called collectively 'saps' and 'each of them has its own degree of non-uniformity' [60a]. Most of them are nameless, but some, which have in them an admixture of fire, have their names like: wine, oils, honey or juice. Wine, for example 'warms not only the body but the soul as well' [60a]. (Perhaps because of a large admixture of fire?) Earth may form pure substances like stone or pottery [60b-d], but these pure substances are formed only after water had been removed from the mixtures of earth and water. Stone is formed in the complicated process in which water in a mixture got disintegrated into air in 'the mixing process' and air escaped the compound. Pottery, on the other hand, has been formed when, from the mixture of earth and water, the 'moisture has been completely expelled by a swiftly burning fire' [60d]. When in the mixture there is, however, more water than earth none of the two processes mentioned above is possible and the substance is 'semisolid and water soluble' only, and the parts of earth in such a mixture are 'the finest' [60d]; Plato identifies two kinds of such substances, soda and salt. But there are still compounds of earth and water that are not soluble by water, but by fire only; these are compounds which are 'compacted' [60e]; Plato lists among them those which possess more earth in them than water like 'glass and generally all stone formations that can be called liquifiable' [61b], and those which contain more water, like wax and incense.

2) The change of state

Substances may change their state due to the interaction with the environment, and this interaction is essentially of the same nature as the one described on the microscopic level. First, solid substances composed out of water, like gold and copper, may be penetrated by fire that breakes them up; as a result the substance 'loses its uniformity, and once that is lost it is more susceptible to motion' [58e];

the substance simply melts. The departure of fire from the melted substance is called 'cooling' and the compression of the substance after the departure of fire is called 'jelling' [59a]. Similarly the departure of fire from the mixtures of water and fire produces more compacted pure substances: when the process takes place above the earth, hail or snow are produced; but when it takes place on the Earth, the two compounded substances, ice and frost, are produced. Of the four substances mentioned, snow and frost are only 'half compounded' [59e]. Removing of water from the compounds of earth and water leads to formation of stones or pottery, as was already mentioned above [60b-c]. When in the mixture water is in abundance it cannot be removed; such a mixture, which is semisolid, can only be solved in water. There are compounds of earth and water that are not soluble at all, but can only be melted, i.e., decomposed by fire [60e-61b].

All changes in the physical state of substances, as is clear from the above summary, may be rendered in terms of the interaction of particles of the environment with the particles of the substance, if it is pure one, or in terms of the interaction with particles of admixtures, if the substance is not pure. It is obvious that Plato sees a kind of hierarchy in the interactions between the substance and the environment. The hierarchy depends on the internal structure of a substance and the size of the particles of the environment. A substance can be in a normal state or it can be compacted. When an earthly substance, for example, is in its normal state it can be dissolved by water only, but not by air or fire, for the gaps between the particles in the compounds of earth are too large. But compressed earth can be dissolved only by fire. Timaeus says: 'For water alone can in this way dissolve earth that isn't forcibly compressed, but when earth is compressed nothing but fire can dissolve it. That is because fire is the only thing left that can penetrate it' [61a]. Water, in turn, in a looser state can be 'dispersed' by air and fire: 'Air does it by entering the gaps, and fire by breaking up triangles' [61a]. When, however, water is compounded, it is fire only that can dissolve it. Finally, '[t]he only way'

in which air that has been condensed by under force can be broken up is into its elemental triangles, and even when it is not forcibly compressed only fire can dissolve it' [61a].

3.2 Qualities and sensations

After completing the description of the varieties of substances Timaeus passes to the description of perceptible qualities and the sensations that they produce in the body. By that time, however, we still know nothing about sense organs, for the construction of the body and the mortal parts of the soul by secondary gods will be given only later, in the last part of the dialogue [69 ff]. Plato has Timaeus acknowledge this inconvenience explicitly, and propose 'begin by taking for granted for now the existence of body and soul' [61d]. This will allow Timaeus to discuss sensation by referring also to sense organs that, as we will learn later, are constructed out of the same four elements as any other objects in the cosmos, and as all terrestrial substances. Timaeus first discusses pairs of opposite perceptible qualities: hot/cold, heavy/light, hard/soft, and smooth/rough, and also pain/pleasure. He considers these opposites as the qualities perceived by the whole body. He continues with the discussion of properties registered by particular sense organs: taste, smell, hearing, and vision.

1) Opposite qualities registered by the whole body

Of the five opposites mentioned above, Timaeus gives a very short description of hard/soft and smooth/rough opposites but elaborates on the other three. The hard/soft opposite is defined with reference to our flesh: whatever it gives way to is hard, and the opposite is soft. The explanation of this is given in terms of the geometrical model: 'Whatever stands upon a small base tends to give way'

[62c]. The base of cube is very 'secure' and the substances composed of cubes and having large density are 'particularly resistent to being displaced' [62c]. As far as the smooth/rough opposite is concerned, Timaeus says that roughness results from the 'combination of hardness with non-uniformity, while smoothness is the result of uniformity's contribution to density' [63e].

The definition of heavy/light is given in terms of motion and resistance of the elements, and this is Plato's second definition of heavy/light property; the first one referred to the number of faces of the elements [56b], and was modified by the notion of density later on [59b]. I will not dwell on the definition of heavy/light here, but instead I will summarize Timaeus' description of the hot/cold for it is the best example illustrating how the geometrical model delivers the explanation of one of the most common 'qualities'.[150]

Plato begins his description of the hot/cold property [61d-62b] by noticing that it is our experience that tells us that fire acts on our bodies by 'dividing and cutting them'. To explain this we have to refer to the geometrical shape of particles of fire, and in particular to 'the fineness of fire's edges, the sharpness of its angles, the minuteness of its parts and the swiftness of its motion' [61e]. These four properties make fire 'severly piercing' and allow sharp cuts into pieces of 'whatever it encounters'. It is then fire with its specific shape and the ability of swift motion and cutting which 'gives us the property that we now naturally call hot [thermon]' [62a].

The name 'cold', Plato says, we attach to the 'experience as a whole' of the shaking of our body (which we call 'shivering' or 'chill'), as well as what causes it [62a-b]. This shaking comes from the interaction of our body with the surroundings. When the moisture penetrates our body, it pushes the 'smaller parts' in the body out. However, a moisture, as consisting of larger parts, is unable to replace these smaller parts that escaped from our body; it rather compresses the

[150] The detailed description of the heavy/light properties can be found in a book-long essay by O'Brien.

moisture in us and 'congeals it' making it 'motionless'. However, as everything unnaturally compressed also the moisture in us 'has a natural tendency to resist such compression, and pushes itself outward in the opposite direction' [62b]. This resistance of the moisture in us against compression of external moisture we experience as shaking of the body which we call 'chill', and to the whole process we attach the name 'cold'.

As is, then, evident from the above description of the hot/cold properties, it is the interaction between the particles of the environment and the particles of our body, or more specifically their structure, motions, and other 'powers' connected with the conglomerates that the particles form, that is responsible for the 'production' of sensations which allow us to assign the hot/cold qualities to the substances. The explanation of these qualities can, then, be given exclusively in terms of the geometrical model. Within this model the 'qualities' are not attached to the substances but emerge as a result of the interaction between the substances and organs of sensation that are composed of the same elements as substances themselves.

2) The pleasure and pain and the mechanism of production of sensations

Sensations, both those registered by the body as a whole and those 'registred throughout the bodily parts' [64a], may be accompanied by pleasure or pain. Search for the causes of pleasure and pain allows Timaeus to present in some detail the mechanism of producing sensations. A sensation starts with a 'disturbance' in some part of the body and ends in 'the centre of consciousness' [64b-c]. While describing this mechanism Timaeus refers to the notion of hardness/softness, and some other properties that may be demonstrated by organs involved in the transmission of sensation. The understanding of this transmission relies, Plato says, on the distinction made earlier between 'what is easily moved and what is hard to

move'. That which is 'easily moved by nature' will transmit in 'a chain reaction' even 'minor disturbance' until it reaches the centre of consciousness and 'reports the property that produced the reaction'. The sight and hearing, as involving fire and air, are examples of sensations transmitted by things that are 'easily moved by nature'. On the other hand, there are parts of the human body which are hard to move; they will not transmit the disturbance through a chain reaction to the centre of consciousness and, as a result, no property will be reported to the centre of consciousness; 'this is true of earth made parts of our bodies like bones or hair'. Some of these 'large parts' may, however, be moved by 'unnatural disturbance that comes upon us with great force and intensity' [64d]; this unnatural disturbance, then, passes on the motion to the entire body, producing the sensation of pain [64e]. Its departure, in turn, 'equally intense..., leading back to the natural state' is perceived as opposite sensation, i.e., as a pleasure. The 'normal' sensations, those involving organs built out of easy-to-move parts, are neutral, for they will produce neither pain nor pleasure. The sensation of seeing, for example, described earlier [45b-e], although it involves 'the cutting, the burning' of the ray (which is, we have to remember, the extension of ourselves) will cause no 'pains in it, nor does the return to its former state yields any pleasure' [64d-e].

3) Sensations produced in the four particular senses

Timaeus discusses also the four sensations that are 'registred throughout the bodily parts' [64a], i.e., taste, smell, hearing, and sight [65b-68d]. Taste discussed at [65c-66c] involves, Timaeus says, the 'properties specifically connected with the tongue', and then he goes on to describe how 'sour', 'tangy', 'bitter', 'salty', and 'pungent' are produced. What is important for us here is that at the very beginning of this discussion of taste Timaeus says that although taste involves to a large extent 'roughness and smoothness', it is also true that 'in common with most

other properties, [the taste] comes about as a result of contractions and dilations' [65c], and this is a reference to the organs perceiving the sensation, for later he will mention 'contracting' of the vessels, for example, as producing sensations. The other sensation is smell [66d-67a[, and we are told that different smells do not originate in different sizes of particles. Smell is rather 'the power belonging to the nostrils' [66d], and our nostrils register odor that comes from things that 'either get damp or decay, or melt or evaporate; for when water changes to air or air to water, odors are given in a transition' [66e]. Air is identified as the sole agent involved in hearing. Plato defines sound as 'the percussion of air by way of the ears upon the brain and the blood and transmitted to the soul' and the hearing as 'the motion caused by percussion that begins in the head and ends in the place where the liver is situated' [67b].

Fire is certainly involved in the production of the sensation of vision [67c-68b]. Already earlier [45c-d] Plato described the formation of 'the ray of sight', and now he is going to describe colours; in this description he will refer to the geometrical shape of the particles of fire, although the formation of the ray of sight required no such reference. The ray of sight is formed when 'a pure fire inside us' mixes with the daylight fire outside us, for whenever the 'visual stream' from our eye is surrounded by daylight composed of fire of similar kind the two coalesce ('like makes contact with like') making up 'a single homogenous body aligned with the direction of the eyes' [45c]. This production of the ray of sight takes place, however, only when 'the internal fire strikes and presses against an external object it has connected with' [45c]. The ray of sight, as 'uniform throughout' is 'uniformly affected' and it transmits the motion of the 'external object' back to the soul, and '[t]his brings about the sensation we call it seeing' [45d].

This simple earlier description, given in the first part of the dialogue, is now modified to account for the possibility of producing colour. Plato defines colour as 'a flame which flows from bodies of all sorts, with its parts proportional to our

sight so as to produce perception' [67c]. We are told further that these 'parts' coming from an object 'impinge on the ray of sight' [67d] and this impact is transmitted by the ray to the centre of consciousness. The 'parts' of the flame which come from the object can be of the same size as the 'parts of the ray of sight itself', or they can be larger or smaller [67d]. If they are of the same size, they are 'imperceptible' and the object is classified as 'transparent'. If, on the other hand, the parts are larger they 'contract' the ray of sight and they produce black colour. If they are smaller they dilate the ray of sight and produce white colour. The contraction and dilating should be understood mechanically, as squeezing and dispersing of the particles of fire in the ray of sight, for Plato make a comparison with properties of fire in producing other sensations. The other colours are produced by the interaction of the ray of sight (as modified by flames from the object) with the moisture in the eye; a resulting turmoil from such an interaction 'gives rise to colours of every hue' [68a].

While describing the process of seeing, Plato make a comparison with properties of fire in producing other sensations, and this tells us that the unified description of sensations is his obvious goal. He says: the smaller parts are 'it cousin of what is cold or hot in the case of the flesh, and, in the case of tongue, with what is sour, or with all the things that generate heat and that we have therefore called *pungent*. So *black* and *white*, it turns out, are properties of contraction and dilation class, which is why they present a different appearance' [67e].

V. CONCLUSIONS

I have attempted in my essay to examine Plato's position on the intelligibility of becoming in the physical world as it is presented in the *Timaeus*. My view is that according to Plato, becoming in the physical world is intelligible, for the physical world is mathematically structured on both the cosmic, and the subcosmic levels. The mathematical structure on the cosmic level is evident to a reflective observer, for he can see regularities in the motions of cosmic objects. The mathematical structure of the physical world on the subcosmic level, on the other hand, can only be postulated, for the becoming on this level appears to be lacking any regularities. Plato makes this seemingly chaotic becoming intelligible by postulating mathematical structure of two kinds. First is the geometrical structure of the four Empedoclean elements on the elementary microcosmic level, and second is the mathematical structure imposed on these elements by the god in the form of proportions. These proportions enable the aggregations of the elementary particles, and in consequence their interactions. The geometrical structure of particles themselves enables their intermutations, for there are exact quantitative relations between the stereometric bodies corresponding to these particles.

The mathematical structure of the universe, in particular the structure of the cosmos as a whole and the proportions the god imposes on the mathematical material of the precosmos, is coded in the Forms or, as it is stated in the *Timaeus*, in the Form of Living Thing; the god constructs the universe as the copy of this unique Form. However, the material the god uses to construct the body of the universe, the four perfect stereometric bodies, is already present in the precosmos and the god has no part in its coming to be. The stereometric bodies are mathematical objects and they spontaneously come into being in the receptacle, caused not by the god, but rather by the mathematical Forms.

Plato's geometrical model of the physical world in the *Timaeus* with its two

components, the mathematical structure of the Empedoclean particles and the interaction between them (which is the result of god's imposition of proportions on them), allows for a unified description of becoming on the terrestrial level: a description of the 'properties' of physical objects and sensations. The properties of physical objects are no longer characteristics of the objects but emerge as the result of interaction between these objects and the organs of sense perception, for both objects and organs are composed of the same elementary particles.

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